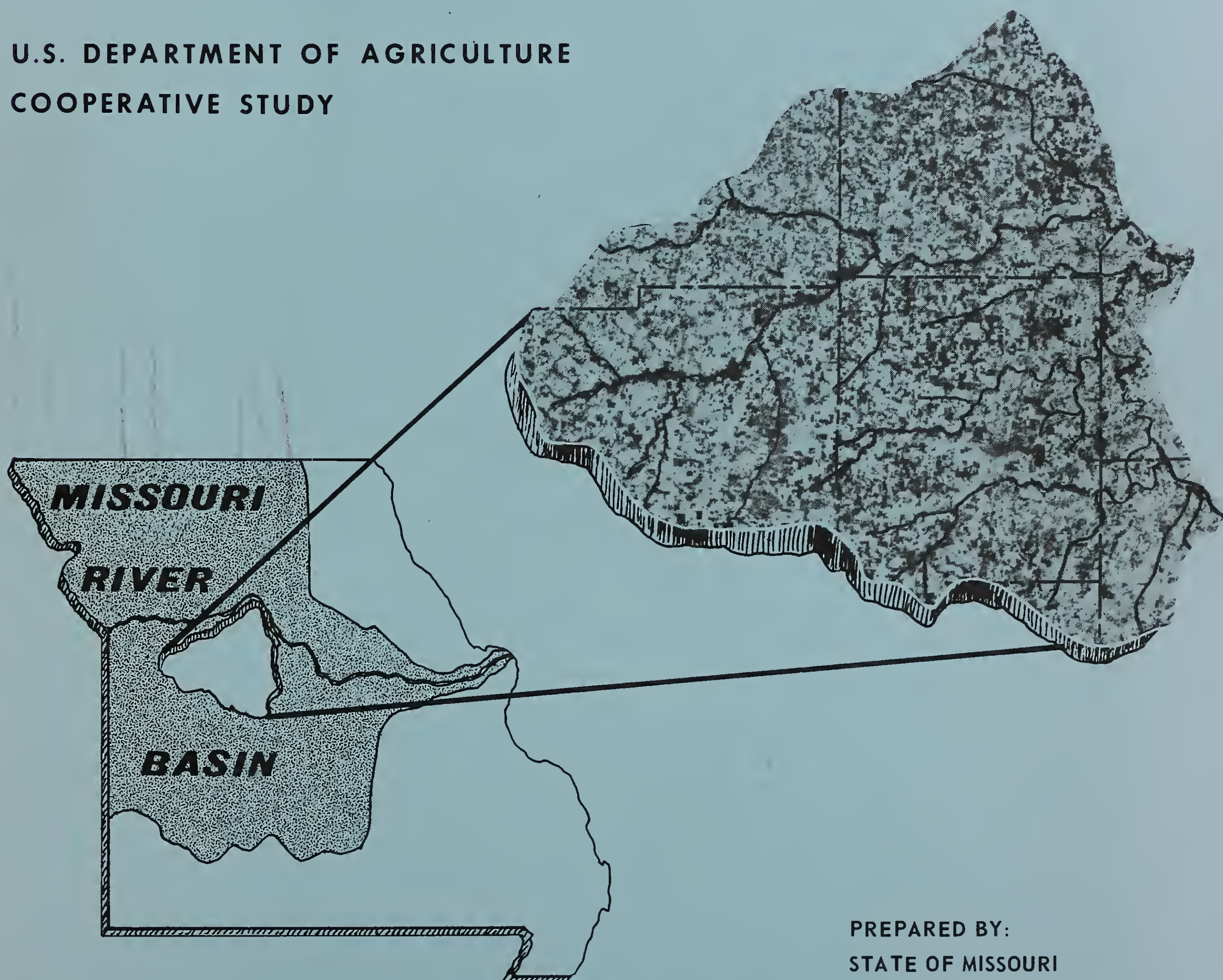
BLACKWATER-LAMINE RIVER BASIN IN MISSOURI

U.S. DEPARTMENT OF AGRICULTURE
COOPERATIVE STUDY



1977

PREPARED BY:

STATE OF MISSOURI
U.S. FOREST SERVICE
U.S. SOIL CONSERVATION SERVICE
U.S. ECONOMIC RESEARCH SERVICE

USDA-SCS-LINCOLN, NEBR. 1977

REPORT ON
THE WATER AND RELATED LAND
RESOURCES

BLACKWATER-LAMINE RIVER BASIN
MISSOURI

Prepared By

U. S. DEPARTMENT OF AGRICULTURE

Economic Research Service
Forest Service
Soil Conservation Service

STATE OF MISSOURI

1977

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
FIELD ADVISORY COMMITTEE, BLACKWATER-LAMINE RIVER BASIN
Columbia, Missouri 65201

July 1, 1977

The Honorable Joseph P. Teasdale
Governor of Missouri
Jefferson City, Missouri

Dear Governor Teasdale:

The attached U.S. Department of Agriculture report presents inventories and opportunities for developing the water and related land resources in the Blackwater-Lamine River Basin. The Department of Agriculture participated in this cooperative survey with the State of Missouri in response to a request from the Office of the Governor, dated February 7, 1967.

The Department of Agriculture's participation in the survey is authorized in the provisions of Section 6, Public Law 566, 83d Congress, as amended. This authorization permits the Department to cooperate with other federal, state, and local agencies in making investigations and surveys within a river basin for development of coordinated watershed programs.

The report presents information obtained from cooperative efforts of the Economic Research Service, Forest Service, and Soil Conservation Service of the Department of Agriculture and by the State of Missouri.

This report completes the assignment of the Department of Agriculture for the Blackwater-Lamine River Basin study.

Sincerely yours,

Kenneth G. McManus

Kenneth G. McManus
State Conservationist
Soil Conservation Service
and
Chairman, USDA Field
Advisory Committee

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BLACKWATER-LAMINE RIVER BASIN, MISSOURI

This addendum shows total beneficial effects, total adverse effects, net beneficial effects, and benefit-cost-ratio based on 6 1/8 percent interest rate. Installation costs are 1972 low bid costs projected to deflated 1980 costs. Crop yields are projected to year 2000 and current normalized prices, WRC, February, 1974 were used for agricultural commodities. Annual effects for total basin and potential watershed projects (Map 25) of the National Economic Development Account for Alternative Plans A, B, and C are as follows:

Table A-1.--Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri 1/

Component	Alternative Plans A	Alternative Plans B	Alternative Plans C
	- - - - - - -	dollars - - - - - - -	- - - - - - -
Total beneficial effects	6,808,810	5,544,530	6,064,300
Total adverse effects	4,697,900	4,275,500	5,214,440
Net benefits	2,110,910	1,269,030	849,860
Benefit-cost-ratio	1.45:1	1.30:1	1.16:1

1/ Corresponds with tables in report:
Summary - Display S-2
Chapter V Display #1, #5, and #9

Table A-2.--Blackwater River Watersheds, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri 1/

Watershed Map No.	Watershed Name	Alternative Plans A	Alternative Plans B	Alternative Plans C
		dollars		
	(Table 104)			
3	Post Oak Creeks			
	Total beneficial effects	458,580	362,810	314,540
	Total adverse effects	219,830	205,960	228,960
	Net benefits	238,750	156,850	85,580
	Benefit-cost ratio	2.09:1	1.76:1	1.37:1
	(Table 105)			
4	Upper Blackwater River			
	Total beneficial effects	1,357,370	994,600	1,527,700
	Total adverse effects	987,240	959,180	1,267,790
	Net benefits	370,130	35,420	259,910
	Benefit-cost ratio	1.37:1	1.04:1	1.21:1
	(Table 106)			
5	Davis Creek			
	Total beneficial effects	646,210	477,050	696,610
	Total adverse effects	459,810	304,540	683,100
	Net benefits	186,400	172,510	13,510
	Benefit-cost ratio	1.41:1	1.57:1	1.02:1
	(Table 107)			
6	Lower Blackwater River			
	Total beneficial effects	384,600	221,220	384,370
	Total adverse effects	330,800	212,630	330,800
	Net benefits	53,800	8,590	53,570
	Benefit-cost ratio	1.16:1	1.04:1	1.16:1
	(Table 108)			
7	Salt Fork			
	Total beneficial effects	744,850	719,760	973,760
	Total adverse effects	594,430	600,930	834,690
	Net benefits	150,420	118,830	139,070
	Benefit-cost ratio	1.25:1	1.20:1	1.17:1
	(Table 103)			
	Blackwater Subbasin			
	Total beneficial effects	3,591,610	2,775,440	3,896,980
	Total adverse effects	2,592,110	2,283,240	3,345,340
	Net benefits	999,500	492,200	551,640
	Benefit-cost ratio	1.39:1	1.22:1	1.17:1

1/ Corresponds with tables in report:
Chapter VII, Tables 103 through 108

Table A-3.--Blackwater River Subbasin, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri 1/

Component	Alternative Plans					
	A		B		C	
	-no-	-dollars-	-no-	-dollars-	-no-	-dollars-
Beneficial effects 2/						
Flood prevention						
In watershed						
Floodwater damage reduction		697,790		844,000		541,710
More intensive land use		175,970		241,620		128,190
Changed land use		185,150		320,550		143,640
Levee system				228,420		
Subtotal		1,058,910		1,634,590		813,540
Downstream						
Floodwater damage reduction		109,530		116,450		51,470
More intensive land use		18,270		24,240		8,050
Changed land use		31,880		41,050		15,430
Subtotal		159,680		181,740		74,950
Total flood prevention		1,218,590		1,816,330		888,490
M&I water supply		53,030		53,030		53,030
Recreation		2,182,900		709,250		2,443,900
Gully stabilization control						253,090
Streambank erosion control						12,320
Drainage				73,400		
Utilization unemployment		137,090		123,430		177,900
Environmental corridor						68,250
Total beneficial effects		3,591,610		2,775,440		3,896,980
Adverse effects 3/						
Flood prevention structure						
Project installation	5	131,820	46	789,150		
OM&R		5,070		33,270		
Multiple MI and FP structure						
Project installation	2	50,840	2	50,840	2	50,840
OM&R		2,190		2,190		2,190
Multiple Rec & FP structure						
Project installation	10	1,461,440	5	563,960	11	1,629,740
OM&R		749,110		249,280		838,170
Gully stabilization structure						
Project installation					63	302,700
OM&R						13,970
Streambank control structure						
Project installation					9	140,980
OM&R						7,920
Levee and drainage						
Project installation				240,140		
OM&R				143,620		
Environmental corridor						89,410
Project administration		191,640		210,790		269,420
Total adverse effects		2,592,110		2,283,240		3,345,340
Net benefits		999,500		492,200		551,640
Benefit cost ratio		1.39:1		1.22:1		1.17:1

1/ Corresponds with tables in report:
Chapter V, Displays #13, #17, and #21
Chapter VII, Table 103
2/ Projections for year 2000. Current normalized prices, WRC, February 1974
3/ Amortized for 100 years @ 6 1/8 percent interest

Table A-4.--Lamine River Watersheds, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri 1/

Watershed		Alternative Plans		
Map No.	Name	A	B	C
		- - - - - - - - -	dollars	- - - - - - - - -
8	Upper Flat Creek (Table 110)			
	Total beneficial effects	851,100	705,530	370,600
	Total adverse effects	442,310	364,120	259,390
	Net benefits	408,790	341,410	111,210
	Benefit-cost ratio	1.92:1	1.94:1	1.43:1
9	Lower Flat Creek (Table 111)			
	Total beneficial effects	623,580	270,210	330,590
	Total adverse effects	414,170	189,850	207,090
	Net benefits	209,410	80,360	123,500
	Benefit-cost ratio	1.51:1	1.42:1	1.60:1
10	Richland Creek (Table 112)			
	Total beneficial effects	426,110	272,760	306,420
	Total adverse effects	331,600	160,120	254,820
	Net benefits	94,510	112,640	51,600
	Benefit-cost ratio	1.28:1	1.70:1	1.20:1
11	Muddy Creek (Table 113)			
	Total beneficial effects	1,005,480	987,070	450,310
	Total adverse effects	688,160	688,530	390,370
	Net benefits	317,320	298,540	59,940
	Benefit-cost ratio	1.46:1	1.43:1	1.15:1
12	Heaths Creek (Table 114)			
	Total beneficial effects	310,930	256,660	359,790
	Total adverse effects	229,550	218,230	292,140
	Net benefits	81,380	38,430	67,650
	Benefit-cost ratio	1.35:1	1.18:1	1.23:1
13	Lamine River (Table 115)			
	Total beneficial effects		276,860	349,610
	Total adverse effects		371,410	465,290
	Net benefits		(94,550)	(115,680)
	Benefit-cost ratio		0.75:1	0.75:1
	Lamine Subbasin (Table 109)			
	Total beneficial effects	3,217,200	2,769,090	2,167,320
	Total adverse effects	2,105,790	1,992,260	1,869,100
	Net benefits	1,111,410	776,830	298,220
	Benefit-cost ratio	1.53:1	1.39:1	1.16:1

1/ Corresponds with tables in report:
Chapter VII, Tables 109 through 115

Table A-5.--Lamine River Subbasin, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri 1/

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 2/						
Flood prevention						
In watershed						
Floodwater damage reduction		720,510		809,170		326,750
More intensive land use		116,190		143,900		36,570
Changed land use		329,400		417,010		80,040
Subtotal		1,166,100		1,370,080		443,360
Downstream						
Floodwater damage reduction		476,550		472,400		233,100
More intensive land use		34,980		36,510		3,690
Changed land use		51,040		55,830		5,610
Subtotal		562,570		564,740		242,400
Total flood prevention		1,728,670		1,934,820		685,760
M&I water supply		86,870		86,870		86,870
Recreation		1,275,650		630,010		1,171,550
Utilization unemployment		126,010		117,390		103,840
Environmental corridor						119,300
Total beneficial effects		3,217,200		2,769,090		2,167,320
Adverse effects 3/						
Flood prevention structure						
Project installation	9	304,140	43	856,680		
OM&R		13,580		37,930		
Multiple MI and FP structure						
Project installation	1	83,410	1	83,410	1	83,410
OM&R		3,460		3,460		3,460
Multiple Rec & FP structure						
Project installation	8	1,039,320	5	563,920	8	1,036,880
OM&R		455,950		229,700		425,470
Environmental corridor						156,470
Project administration		205,930		217,160		163,410
Total adverse effects		2,105,790		1,992,260		1,869,100
Net benefits		1,111,410		776,830		298,220
Benefit cost ratio		1.53:1		1.39:1		1.16:1

1/ Corresponds with tables in report:
Chapter V, Displays #25, #29, and #33
Chapter VII, Table 109
2/ Projections for year 2000. Current normalized prices, WRC, February 1974
3/ Amortized for 100 years @ 6 1/8 percent interest

U.S. DEPARTMENT OF AGRICULTURE

BLACKWATER-LAMINE RIVER BASIN, MISSOURI

SUMMARY

This cooperative study was made under the authority of Section 6 of the Watershed Protection and Flood Prevention Act--Public Law 83-566, as amended in response to a request by the Governor of Missouri dated February 7, 1967.

Participation within the USDA was by the Economic Research Service, Forest Service and Soil Conservation Service. Participation by the State of Missouri was through the Divisions of the Missouri Department of Natural Resources and the Missouri Department of Conservation.

The report will contribute to formulating a state water plan by the State of Missouri and will serve as a guide for coordinating land and water projects and programs of local, federal and state agencies. It will assist the U.S. Department of Agriculture in administering the PL-566 Small Watershed Program.

OBJECTIVE AND NATURE OF THE STUDY

The broad objective of this study is to provide information needed by decision makers for the orderly conservation, development, management and utilization of the water and land resources. The State of Missouri objectives included the following: the conservation, development, management and use of water and land resources to meet seasonal and long-range requirements; contribute to the local economic base; implementation for recreation experience; retention of historic uniqueness and apply the multiple use concept to serve the greatest number of people.

During the study, Principles and Standards were developed by the U.S. Water Resource Council. To the extent possible, this new policy was used as illustrated by the displays of three alternative plans and the evaluations using the 4 account system.

ECONOMIC AND ENVIRONMENTAL SETTING

The Blackwater-Lamine River Basin consists of a 2659.84 square mile area located in west-central Missouri south of the Missouri River and east of Kansas City. It encompasses 3.8 percent of the state and includes land in eight counties. Interstate 70 traverses the basin from east to west.

Settlement began in 1804. Population increased until the turn of the century and then declined until the 1950's. During the 1950's population again began to increase. By 1970, 107,000 people resided in the basin. About 45 percent of the population live in the three major cities of Sedalia, Warrensburg, and Marshall.

Because of the growing local economy and the availability of jobs in the Kansas City area, employment has been high. About 25 percent of the people commute over county lines to their jobs. Future employment is expected to

decrease in agriculture and increase in manufacturing, services, wholesale and retail trade.

The land and climate of the basin is conducive to a wide range of crops and forest products. The demand for these products is expected to increase in the future.

PROBLEMS AND NEEDS

Land erosion is a major problem causing economic and environmental damage. The annual gross erosion in the basin is about 21.3 million tons or 12.5 tons per acre. Of the annual erosion, about 74 percent (9.2 tons per acre) occurs as sheet erosion, 11 percent (1.4 tons per acre) as gully erosion and 15 percent (1.9 tons per acre) as flood plain scour, accelerated channel and roadside erosion (Display #S-1). 1/

Ninety percent of the sheet erosion occurs on tilled cropland. Gully erosion voids about 3,100 acres annually and annual flood plain scour affects some 12,800 acres. About 5.5 million tons or 35 percent of the gross erosion from the basin enters the Missouri River. Stream gage records on the Blackwater River at Blue Lick shows an accretion of six feet of sediment since 1920. Older residents indicate that as much as 18 feet of sediment has been built-up on the Blackwater River flood plain and in the channel near the outlet of Davis Creek since 1910 when channeling in the upper reaches began.

Frequent inundation and long duration of flooding is a major problem affecting agricultural production on 113,370 acres (Table S-1). About 97,000 acres are flooded annually. Flooding causes additional damage to roads, bridges and other structures in the flood plain. Total average annual flood damage of 4.5 million dollars is projected for the year 2000.

Table S-1.--Floodwater Damage - Year 2000, Blackwater-Lamine River Basin, Missouri

Item	Damages
	--dollars--
Crop and pasture	2,926,240
Other agricultural	292,630
Road and bridge	243,680
Land damages	617,490
Indirect	408,020
Total damage	4,488,060
	--acres--
Total flood plain	113,370
Average annual	96,940

Price base: Current normalized prices, WRC, February 1974.

A significant problem related to the forest resource is the continued reduction of land in commercial forest. The 1970 base of 298,000 acres in

1/ All displays and tables not identified as to source are from data developed by the cooperative study.

Display # S-1.--Capability of Alternative Plans to Satisfy Study Items - Blackwater-Lamine River Basin, Missouri

Study Item Description	Unit	Problem or need	Alternative Plans - Providing and Remaining					
			Alternative Plan A		Alternative Plan B		Alternative Plan C	
		Quantity	Provides	Remaining	Provides	Remaining	Provides	Remaining
I. Reduction of erosion and sedimentation								
A. Accelerated land treatment								
Cropland	acres	428,900	125,300	303,600	125,300	303,600	248,400	180,500
Pasture	acres	197,400	34,900	162,500	34,900	162,500	134,600	62,800
Forest	acres	174,200	30,000	144,200	30,000	144,200	60,000	114,200
Subtotal	acres	800,500	190,200	610,300	190,200	610,300	443,000	357,500
Sheet erosion reduction	tons/year	15,723,000	8,178,000	7,545,000	8,178,000	7,545,000	14,140,000	1,583,000
B. Gully, roadside and streambank								
Gully stabilization structures	number	3,403	2,018	1,385	2,018	1,385	2,385	1,018
Roadside erosion control	miles	2,712	0	2,712	0	2,712	2,712	0
Streambank erosion ctonrol structures	number	18	0	18	0	18	9	9
Streambank controlled	feet	290,800	0	290,800	0	290,000	147,000	143,000
Gully erosion reduction	tons/year	2,476,000	1,342,000	1,134,000	1,342,000	1,134,000	2,451,000	25,000
Other erosion reduction	tons/year	3,142,000	1,299,000	1,843,000	1,299,000	1,843,000	2,063,000	1,079,000
Total erosion reduction	tons/year	21,341,000	10,819,000	10,522,000	10,819,000	10,522,000	18,654,000	2,687,000
Grade stabilization structures	number	63	0	63	0	63	63	0
C. Sediment delivered to basin outlet	tons/year	5,459,000	2,586,000	2,873,000	2,848,000	2,611,000	4,200,000	1,259,000
	acre/feet	3,000	1,400	1,600	1,500	1,500	2,300	700
II. Reduction of flooding								
A. Single purpose structures	number	n/a	14	- -	89	- -	- -	- -
Sediment pool	acres	n/a	1,369	- -	4,834	- -	- -	- -
B. Multiple purpose structures	number	n/a	21	- -	13	- -	22	- -
C. Levees	miles	13	0	13	13	0	0	13
Protected area	acres	3,243	0	3,243	3,243	0	0	3,243
Drainage impaired by levees	acres	n/a	- -	- -	1,950	- -	- -	- -
D. Drainage area controlled	square mile	n/a	910	- -	1,047	- -	627	- -
	percent	n/a	34	- -	39	- -	24	- -
E. Floodwater damage reduction	dollars	4,488,060	2,004,380	2,483,680	2,242,020	2,246,040	1,153,030	3,335,030
	percent	n/a	45	- -	50	- -	26	- -

Display # S-1.--Capability of Alternative Plans to Satisfy Study Items - Blackwater-Lamine River Basin, Missouri (continued)

Study Item Description	Unit	Problem or need	Alternative Plans - Providing and Remaining					
			Alternative Plan A		Alternative Plan B		Alternative Plan C	
		Quantity	Provides	Remaining	Provides	Remaining	Provides	Remaining
III. Water supply								
A. Lakes and towns	number	8	3	5	3	5	3	5
B. Surface area	acres	n/a	1,210	- -	1,210	- -	1,210	- -
C. Capabity	m.g.d.	19.74	13.07	6.67	13.07	6.67	13.07	6.67
IV. Recreation								
A. Reservoirs								
Lakes	number	n/a	18	- -	10	- -	19	- -
Surface area	acres	n/a	6,300	- -	2,430	- -	6,500	- -
Facilities	acres	n/a	12,000	- -	4,860	- -	13,000	- -
B. Environmental corridors								
Length	miles	108	0	108	0	108	40	68
Area	acres	71,208	0	71,208	0	71,208	25,000	46,208
C. Recreation potential								
Reservoir capacity	visitor days	n/a	2,305,800	- -	892,910	- -	2,410,400	- -
Environmental corridor capacity	visitor days	n/a	- -	- -	- -	- -	250,000	- -
Total recreation	visitor days	7,583,720	2,305,800	5,277,920	892,910	6,690,810	2,660,400	4,923,320
V. Fish and wildlife								
A. Improve terrestrial wildlife habitat (through changing land use)	acres	155,700	0	155,700	0	155,700	155,700	0
B. Improve and protect streams from biological degradation	miles	13	0	13	0	13	13	0
C. Area of permanent water in lakes	acres	n/a	8,879	- -	8,474	- -	7,710	- -

forest land is projected to be 220,000 acres by year 2000 and 125,000 acres by the year 2020 if clearing for cropland, pasture and other uses continue. The grazing of 194,600 acres of forest land contributes to its poor hydrologic condition, reduces wildlife habitat and timber production and causes excessive erosion.

The demand for wood products is projected to increase from 1.9 million cubic feet in 1970 to 8.4 million cubic feet in the year 2000 while supply is projected to increase from 2.5 million to 5.8 million cubic feet. Full use of the forest resources for recreation is inhibited by lack of developed facilities.

In the northern half of the basin, the ground water yields are low and the quality is variable and generally below standards set by the drinking water standards of the U.S. Public Health Service. Since stream flow is not a reliable source, storage of surface water is often the only practical alternative for providing water. Additional municipal water will be needed for 22 communities by the year 2000. Wells can supply water for 14, but surface storage will be required for the remaining 8 communities.

The source of pollutants in surface water includes soil from erosion, effluents from waste disposal systems and agriculturally related wastes. Suspended sediment from erosion is the most widespread pollutant. Secondary treatment is provided in all but nine communities which have individual systems. High nitrate and phosphate discharges from treatment plants occasionally causes pollution immediately downstream. During low flow periods of the Blackwater River, saline springs having a high concentration of salt contribute to the flow.

The major recreation problem is the shortage of adequate facilities to meet the demand, especially for water-based recreation. The number of visitors at Knob Noster State Park has more than tripled since 1967 resulting in the deterioration of the park. About 74 percent of the demand is from population centers outside the basin, particularly Kansas City. About 95 percent of the outside demand is within the 1/2 hour travel time zone.

The major problem concerning fish and wildlife resources is the declining quality and quantity of habitat. Also the limited access on many private lands restricts the resource use. Wildlife habitat is far from being optimized under present land use; wildlife resources will probably continue to deteriorate unless measures are taken to improve habitat conditions. The fishery resource is adversely affected by the quality of water, channelization of streams and inadequate management.

Environmental corridor reaches were evaluated for environmental quality. On a statewide scale the quality of corridor reaches in the Blackwater Subbasin is less than the average for the state while the Lamine Subbasin is about average. An adequate survey of historic and pre-historic sites having significant value has not been made although archeologist indicate that the potential for finding sites is high within the corridor areas.

FUTURE ALTERNATIVE LAND USES

Since most of the land in the basin is owned and managed by farmers their decisions will play an important role in future land and water use and development. Net farm income can be increased substantially by shifting land to those crops projected to be in demand in the future. Some of these shifts in land use will adversely affect environmental quality. Two of the most important consequences could be the loss of bottom land forest and the increase in erosion in upland areas.

Net farm incomes can also be increased by flood control and drainage. The level of benefits accruing to agriculture will depend mostly upon the demand for farm products. If the demand is high and farmers tend to maximize income from each acre of land, benefits will be highest and environmental quality will be most adversely affected. However, if the demand for products is as expected and farmers adjust their production minimizing the cost of production, benefits to flood control and drainage will be lower and environmental damage reduced.

ALTERNATIVE PLANS

Three alternative plans were developed for this report (Display S-2). These plans were formulated to meet the broad objective of enhancing the resource base, and encompass varying degrees of land treatment to reduce erosion and sediment. The "going program" administered under PL-46 is projected to treat 283,800 acres which would result in 45 percent of the land being adequately treated. It also provides for installation of 367 gully control structures or about 20 percent of the number needed. Total cost of the "going program" is $12,050,600.

ALTERNATIVE PLAN A

Alternative Plan A proposes to accelerate the installation of land treatment practices by treating an additional 190,200 acres of land. This would include the treatment of 125,300 acres of cropland. Erosion control practices of minimum tillage, terraces, diversions and waterways being the most significant practices. Additional treatment of 34,900 acres of pasture is proposed with improvement of cover being the predominant need. Reforestation, timber stand improvement, and grazing control on 30,000 acres of forest land is included in the land treatment. Also 2,018 stabilization structures would be installed. The accelerated land treatment would increase the adequately treated land to 57 percent of total inventory land by year 2000 at a cost of $16,415,000. Gross erosion would be reduced from 21.3 to 10.5 million tons per year. The amount of sediment leaving the basin annually would be reduced from 3,000 to 1,600 acre feet.

Structural measures include 14 single purpose flood prevention structures and 21 multiple purpose structures. Three of these multiple purpose structures have municipal and industrial water supply and 18 have recreation storage combined with flood prevention. This system would control 910.88 square miles or 34 percent of the drainage area. Average annual floodwater damages would be reduced from $4,488,060 to $2,483,680 or a reduction of 45 percent. Land enhancement benefits of $957,530 would occur from more

Display # S-2.--Display of Alternative Plans, Blackwater-Lamine River Basin, Missouri

Plan elements	National Economic Development: Beneficial effects	National Economic Development: Adverse effects	Environmental Quality: Beneficial and adverse effects	Regional Development: Beneficial effects: Basin	Regional Development: Beneficial effects: Rest of nation	Regional Development: Adverse effects: Basin	Regional Development: Adverse effects: Rest of nation	Social Well Being: Beneficial and adverse effects	Program Opportunities: USDA Program opportunities	Program Opportunities: Other Program opportunities
	- - - dollars - - -									
Alternative Plan A Dams FP 14 No MP 21 No Land treatment 1/ 474,000 Ac Gully stabilization structures 1/ 2,385 No 1/ Installation plus technical assistance cost: Going $12,050,600 Accelerated $16,415,000 Benefits not evaluated monetarily.	6,791,390 Net beneficial effects 2,370,640	4,420,750	1. Create lakes 8,379 surface acres. 2. Associated land areas for recreation facilities 12,000 acres. 3. Permanent inundation streams Perennial 28 miles Intermittent 20 miles 4. Changed land use of 5,682 acres of pasture and 5,640 acres of forest to cropland resulting from flood protection. 5. 153,165 acres of managed forest land retains natural beauty.	1. Income - dollars 7,832,770 Net beneficial effects 4,186,460 2. Net employment - 217.0 semi-skilled jobs for 10 years 53.4 permanent semi-skilled jobs 85.0 permanent seasonal semi-skilled jobs 1.0 skilled forester	-1,041,380 -1,815,820	3,646,310	774,440	1. Create 53.4 low to medium income permanent jobs. 2. Create reservoir areas will increase 315,000 fisherman days. 3. Inundation of stream fishing with loss of 3,200 fisherman days. 4. Inundation of terrestrial and riparian habitat of reservoir areas with loss of 1,485. 5. Provide public use areas with developments for additional 2,574 hunter days. 6. Create 2,730,950 water-based recreation visitor days.	10 PL-566 early action watersheds. Land treatment 283,800 Ac. - PL-46 and ACP 190,200 Ac. - PL-566 Gully stabilization 367 No. - PL-46 and ACP 2,018 No. - PL-566 Cooperative Forest Management	Construction of one multiple purpose FP-Rec structure in Upper Blackwater Watershed.
Alternative Plan B Dams FP 89 No MP 13 No Levees 13.1 Mi Land treatment 1/ 474,000 Ac Gully stabilization structures 1/ 2,385 No 1/ Installation plus technical assistance cost: Going $12,050,600 Accelerated $16,415,000 Benefits not evaluated monetarily	5,536,560 Net beneficial effects 1,546,980	3,989,580	1. Create lakes 8,474 surface acres. 2. Land area for recreation 4,860 acres. 3. Permanent inundation streams Perennial 5.1 miles Intermittent 20.5 miles 4. Changed land use in 6,655 acres of pasture and 8,123 acres of forest to cropland resulting from flood protection. 5. 183,798 acres of managed forest land retains natural beauty.	1. Income - dollars 7,985,850 Net beneficial effects 5,139,555 2. Net employment - 226.9 semi-skilled jobs for 10 years 7.5 permanent semi-skilled jobs 33.4 permanent seasonal semi-skilled jobs. 1.0 skilled forester	-2,449,290 -3,592,575	2,846,295	1,143,285	1. Create 7.5 low to medium income permanent jobs. 2. Create reservoir areas will increase 121,500 fisherman days. 3. Inundation of terrestrial and riparian habitat at reservoir areas with loss of 1,364 hunter days. 4. Provide public use areas with recreation developments for additional 928 hunter days. 5. Inundation of stream fishing will decrease 675 fisherman days. 6. Create 892,910 water-based recreational visitor days.	10 PL-566 early action watersheds. 1 PL-566 long range watershed Land treatment 283,800 Ac. - PL-46 and ACP 190,200 Ac. - PL-566 Gully stabilization 367 No. PL-46 and ACP 2,018 No. - PL-566 Cooperative Forest Management	
Alternative Plan C Dams MP 22 No Stabilization structures 63 No Streambank control structures 9 No Environmental corridors 40 Mi Land treatment 1/ 726,800 Ac Gully stabilization structures 1/ 2,752 No Roadside erosion 1/ 2,712 Mi 1/ Installation plus technical assistance cost: Going $12,050,600 Accelerated $49,436,000 Benefits not evaluated monetarily	6,057,170 Net beneficial effects 1,156,450	4,900,720	1. Create lakes 7,710 surface acres. 2. 13,000 acres to be developed for recreation facilities. 3. Permanent inundation streams Perennial 22.4 miles Intermittent 13.4 miles 4. Provide 25,000 acres of environmental corridors. 5. Conversion of Class IV, VI and VII cropland and pasture to 13,100 acres of tame grasses, 41,800 acres of warm season grasses and 100,800 acres of afforestation. 6. Changed land use on 1,803 acres of pasture and 2,494 acres of forest to cropland resulting from flood protection.	1. Income - dollars 5,800,120 Net beneficial effects 1,952,945 2. Net employment - 349.8 semi-skilled jobs for 10 years 112.5 permanent semi-skilled jobs 89.1 permanent seasonal semi-skilled jobs 1.0 skilled forester	257,050 -796,495	3,847,175	1,053,545	1. Create 112.5 low to medium income permanent jobs. 2. Creation of reservoir areas will provide an increase of 325,000 fisherman days. 3. Inundation of stream fishing resulting in a loss of 2,150 fisherman days of stream fishing. 4. Inundation of terrestrial and riparian habitat of reservoir areas results in loss of 1,284 hunter days. 5. Provide public use areas with recreation developments for additional 2,512 hunter days. 6. Create 2,410,400 water-based recreational visitor days. 7. Create an environmental corridor with 250,000 recreational visitor days annually.	10 PL-566 early action watersheds 1 PL-566 long range watershed Land treatment 283,800 Ac. - PL-46 and ACP 443,000 Ac. - PL-566 Gully stabilization 367 No. - PL-46 and ACP 2,385 No. - PL-566 Roadside erosion control 2,712 Mi. - PL-566 or RC&D Cooperative Forest Management	Construction of one multiple purpose FP-Rec structure in Upper Blackwater Watershed Purchase easements on 25,000 acres of environmental corridors

intensive and changed land use in certain reaches with a high degree of flood control.

Water supply is provided for Sedalia, Higginsville and Sweet Springs. These three reservoirs will provide a capacity of 13.07 million gallons per day (mgd).

This plan provides 2,305,800 visitor days or about 30 percent of the water based recreation needed by the year 2000. The 18 reservoir sites have 6,300 surface acres of water and include 12,000 acres of land for basic recreation facilities. The recreation activities planned are fishing, boating, camping, picnicking, sight seeing, and swimming. Annual benefits are $3,458,550.

Total beneficial effects for Alternative Plan A are $6,791,390 and total adverse effects $4,420,750 resulting in net benefits of $2,370,640.

ALTERNATIVE PLAN B

The accelerated land treatment program proposed in Alternative Plan A is also applicable to Plan B. The amount of sediment leaving the basin will be slightly different because of the project formulation changes.

The structural measures include 89 single purpose flood prevention and 13 multiple purpose structures. Three of these include storage for municipal and industrial water supply and 10 include storage for recreation and flood prevention. This system would control 1047.13 square miles or 39 percent of the drainage area. Average annual damages would be reduced from $4,488,060 to $2,246,040 or a reduction of 50 percent. Land enhancement benefits of $1,300,800 would occur on certain reaches with adequate flood protection. This alternative includes 13 miles of levees along the mainstem of the Blackwater River from the junction of Clear Creek to Highway 23 south of Concordia. This system includes a pumping plant, mains and laterals to benefit 3,243 acres from flooding and excessive water.

Water supply in this plan would be identical to that provided by Alternative Plan A. The 10 multiple purpose reservoirs can supply 892,910 visitor days or 12 percent of the recreation demand. These reservoirs have 2,430 surface acres of water and 4,860 acres of land for basic recreation facilities. Annual benefits from recreational activities are $1,339,260.

Total beneficial effects for Alternative Plan B are $5,536,560 and total adverse effects $3,989,580 resulting in net benefits of $1,546,980.

ALTERNATIVE PLAN C

Alternative Plan C emphasizes environmental concerns by accelerating to a higher degree erosion control measures and land use changes. This plan proposes an interspersion of 145,400 acres forest land and grassland on Classes IV, VI and VII lands. Alternative Plan C proposes afforestation on 100,800 acres; 36,700 acres from cropland and 64,100 acres from pasture.

Classes IV, VI and VII lands having a low woodland site potential, 14,600 acres of cropland and 27,200 acres of existing pasture are converted

to native warm season grasses and managed as native grassland. About 13,100 acres of Class IV cropland would be converted to tame grasses. Reforestation on 2,900 acres, timber stand improvement on 30,290 acres and grazing reduction on 26,810 acres are proposed to accelerate the forest treatment program.

Accelerated erosion control is planned with 2,385 additional gully stabilization structures and 2,712 miles of roadside erosion control. The combined land treatment and structural program is estimated to reduce erosion from 21.3 to 2.7 million tons annually. Sediment leaving the basin would be reduced from 3,000 to 700 acre feet. This program would increase the adequately treated land to 74 percent of total inventory land by year 2000. Installation cost of the accelerated land treatment program is $49,436,000.

Structural measures include 22 multiple purpose structures; 3 with storage for water supply and flood prevention and 19 with storage for recreation and flood prevention. This system would control 627.50 square miles or 24 percent of the drainage area. Average annual damages would be reduced from $4,488,060 to $3,335,030 or a reduction of 26 percent. Land enhancement benefits amount to $427,490. This plan also includes 63 grade stabilization structures and 9 streambank erosion control structures.

Water supply for municipal and industrial use in this plan is identical to that provided in Alternative Plans A and B. Water based recreation provides 2,410,400 visitor days or 32 percent of the demand. The 19 structures have 6,500 surface acres of water plus 13,000 acres of lands for basic recreation facilities. Annual benefits are estimated at $3,615,450.

Alternative Plan C provides 24,000 acres or 40 miles of environmental corridors along Clear and Heath Creeks and the Lamine River. In these areas of natural beauty, the recreational visitor days provided are 250,000 annually. The beneficial effects amount to $187,550 and adverse effects amount to $225,180.

Alternative Plan C includes land use changes and other measures that will create and improve wildlife habitat conditions reversing the trend in habitat loss.

Total beneficial effects in Alternative Plan C are $6,057,170 and total adverse effects are $4,900,720 resulting in net benefits of $1,156,450.

OPPORTUNITIES FOR DEVELOPMENT THROUGH USDA PROGRAMS

All counties in the basin except Morgan County have organized soil and water conservation districts to carry out a land treatment program. There are 398,700 acres now adequately treated. By year 2000, the "going program" is expected to treat an additional 283,800 acres of the 1,526,700 acres of inventory land through SCS, PL-46, ASCS and the State-Federal forestry programs.

An opportunity to accelerate the land treatment is provided through PL-566, the Small Watershed Program. Alternative Plans A and B provide technical assistance to accelerate the land treatment on 190,200 acres, while Alternative Plan C provides for the treatment on 443,000 acres.

Except for one multiple purpose reservoir, implementation of the structural measures proposed can be accomplished through the PL-566 Small Watershed Program. Twelve watersheds were identified as needing early action plans for development which should be made in the next 10-15 years (Table S-2). One watershed was placed in the long range category. The structural measures include flood retarding, gully control, and multiple use structures with flood prevention and water supply or recreation developments.

Opportunities for development are more favorable for meeting fishing needs than for meeting the wildlife resources hunting demands. Most opportunities for meeting fishing needs can be achieved with present authorities of water resource development. An intensive program providing for subsidies would be required to achieve adjustments in land use on private lands to meet hunting demands. Few authorities exist to effectively encourage these adjustments.

COORDINATION AND PROGRAMS FOR DEVELOPMENT

Water and related land development in the basin can be accomplished primarily under programs administered by the U.S. Department of Agriculture. Additional development of resources and regulations of resource utilization are accomplished through state and local governments.

The laws of Missouri provide for the establishment of special benefit districts who can plan and construct flood control and drainage improvements. A PL-566 Small Watershed Project can be developed under this law through coordination of local, state and federal entities.

In the Upper Blackwater Watershed one multiple purpose reservoir will require coordination with the Corps of Engineers and the Missouri Division of Parks and Recreation. Since it is larger than can be built under the authority of PL-566, planning and constructing would need to be accomplished by the COE. The recreation features need to be coordinated with the Missouri Recreation and Park Board.

CONCLUSION

Alternative Plans A, B and C as developed, evaluated and displayed in this report provide for a range of development opportunities. A careful study of the summary displays will provide an overall understanding of each alternative and its relation to the potential of the basin and to each other (Display S-3).

The comparison of no project development and the alternatives will point out the areas in which decisions are needed to select a plan. Both state and local leadership should agree upon the extent of development desired in relation to the trade-offs. Most of the land treatment needs and the structural measures displayed in the alternative can be installed under the provisions of the PL-566, Small Watershed Program and the USDA "going" programs. Adequate funding of the current USDA programs is needed to facilitate the application of land treatment measures.

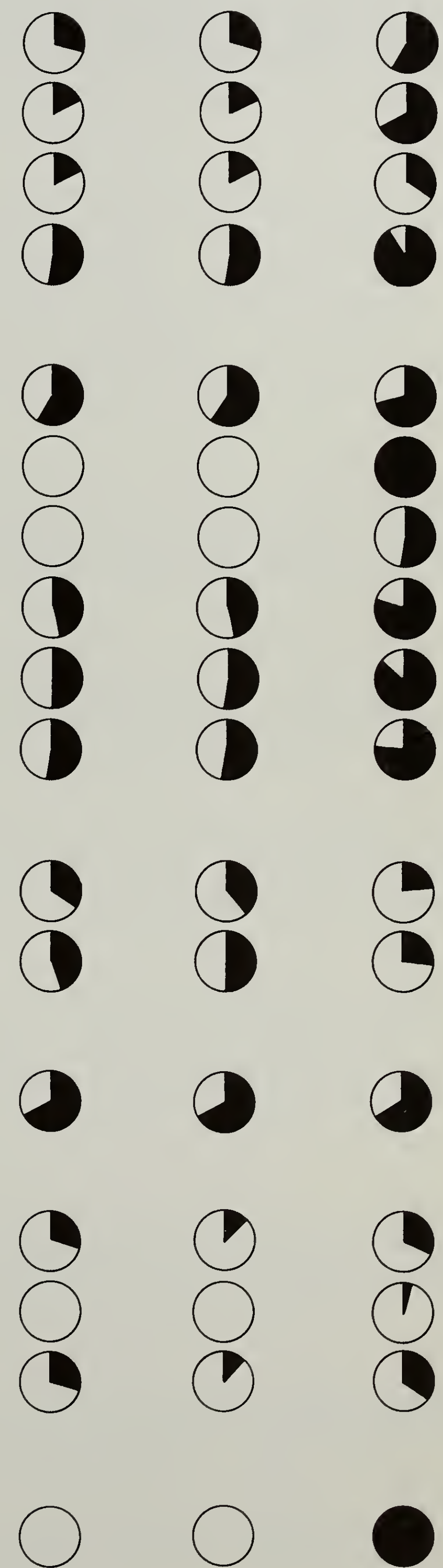
Table S-2.--Net Beneficial Effects of Early Action and Long Range Watersheds, National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Watershed No	Watershed name	Drainage area	Net benefits from structural measures - Alternative Plans A	B	C	Principle structural and land treatment features 1/
		sq. mi.	- - - - - - - dollars	- - - - - - -		
Early Action						
3	Post Oak	135.52	252,880	173,310	104,340	FR, R, SEC, GEC
4	Upper Blackwater	329.22	419,990	93,070	338,050	FR, R, SEC, GEC, EC
5	Davis	241.34	210,570	193,200	60,780	FR, R, SEC, GEC, M&I
6	Lower Blackwater	270.02	70,960	17,810	70,720	FR, R, SEC
7	Salt Fork	353.71	182,590	160,470	182,080	FR, R, SEC
8	Upper Flat	226.91	434,530	364,060	120,770	FR, R, SEC, M&I
9	Lower Flat	173.46	232,230	94,990	134,650	FR, R, SEC
10	Richland	137.46	115,930	126,050	66,680	FR, R, SEC
11	Muddy	294.85	357,120	344,380	80,340	FR, R, SEC
12	Heath	106.82	93,840	53,080	85,120	FR, R, SEC, EC
Long Range						
13	Lamine River	171.01		-73,440	-87,080	FR, R, SEC, EC

1/ FR - Flood Reduction
R - Recreation
SEC - Sheet Erosion Control
GEC - Gully Erosion Control
M&I - Municipal and Industrial Water Supply
EC - Environmental Corridors

Display # S-3.--Capability of Alternative Plans, Blackwater-Lamine River Basin, Missouri

Study Item Description	Units	Alternative Plans: Plan A	Plan B	Plan C
		(Percent of needs satisfied)		
I. Reduction of erosion and sediment				
A. Accelerated land treatment				
Cropland	acres			
Pasture	acres			
Forest	acres			
Sheet erosion reduction	tons/year			
B. Gully, roadside and streambank				
Gully stabilization structure	number			
Roadside erosion control	miles			
Streambank erosion control	feet			
Gully and other erosion reduction	tons/year			
Total erosion reduction	tons/year			
C. Sediment at basin outlet	tons/year			
II. Reduction of flooding				
Drainage area control	percent			
Damage reduction	dollars			
III. Water supply				
Capacity	m.g.d.			
IV. Recreation				
Reservoir capacity	visitor days			
Environmental corridor	visitor days			
Total recreation capacity	visitor days			
V. Fish and Wildlife				
Improved upland wildlife habitat through changing land use	acres			



The participation of the Division of Parks and Recreation, Missouri Department of Natural Resources, will be necessary to implement the recreation plans displayed in the alternatives. Coordination with the Corps of Engineers will be needed if the multiple purpose structure on Clear Creek is selected for implementation.

Individual watershed projects can be implemented but the downstream benefits on the Lamine River and to some extent on the Blackwater River point out the need to develop concurrent watershed projects.

U. S. DEPARTMENT OF AGRICULTURE

BLACKWATER-LAMINE RIVER BASIN

MISSOURI

INTRODUCTION

The Cooperative Type 4 Study of the Blackwater-Lamine River Basin was initiated in response to a request from the Governor of the State of Missouri, to the U. S. Secretary of Agriculture, dated February 7, 1967. The study was funded in fiscal year 1970.

The study was initiated by petition of local groups who were concerned with the present problems and future land and water needs. These groups represented the drainage districts, towns, cities, county courts and soil conservation districts as well as the local citizen. The concerns generally expressed were flooding; sediment; drainage; streambank, gully and sheet erosion; and inadequate water quantity and quality in towns and rural areas. The State of Missouri expressed their concern for input to the state water plans.

The U. S. Department of Agriculture was interested in the study because of its responsibility concerning proper resource use and management through assistance to Missouri's Soil and Water Conservation Districts and Watershed Sub-Districts.

The study was a cooperative state-federal endeavor. It was requested by the State of Missouri and input was provided by state agencies. Several meetings were held with representatives of local and regional groups to identify problems and needs and review alternative solutions.

The study proceeded and correlated with the phase-in period of the U. S. Water Resource Council's Principles and Standards for water and related land resource planning. Some of the USDA procedures for implementing Principles and Standards were incorporated into the report.

Three alternative plans are displayed that will give planners a range of solutions. These alternative plans are displayed under the accounts of National Economic Development, Regional Development, Environmental Quality and Social Well-Being. A selected plan was not developed for this study.

OBJECTIVES

The objectives of this study and report were to provide local, state and federal decision makers with alternative plans needed for the orderly conservation, development, utilization and management of the water and land resources.

In addition, the following objectives for the conservation, development, management and use of water and land resources, developed by the State of Missouri, were considered during the progress of the study:

1. Development and management to assure a water supply adequate to

meet seasonal long-range requirements for domestic, municipal, industrial, agricultural, fish and wildlife, recreation, power, navigation, and quality control purposes from surface or ground water sources or from a combination of the two.

2. Contribution to the establishment, diversification, and stabilization of a local economic base having capability to sustain acceptable living standards within the community and providing sufficient employment opportunities to reduce migration.

3. Implementation of land use practices that effectively reduce siltation and loss of the land base through irresponsible practices associated with farming, mining, construction, forestry, and other control actions of man.

4. Improvement of water quality through control of municipal and industrial waste discharge, agricultural pollution, acid mine drainage, and littering to permit and encourage additional use of the available water supply at any location and at any period of time.

5. Maintenance of an environment that offers a diversity of recreational and aesthetical experiences in keeping with the regional or local resource capability.

6. Retention of those basic features which contribute to the historic uniqueness and character of the state and its several regions.

7. Application of the multiple use concept to water and related land resources in a manner that will permit utilization of the resource base in an efficient and balanced manner to serve the greatest number of people.

AUTHORITY

This study was made under the authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83d Congress (Public Law 566, as amended). Under this Act, the Secretary of Agriculture has authority to cooperate with other Federal, State and Local Agencies in their investigations of rivers, watersheds, and other waterways to develop coordinated plans and programs.

USDA AND SPONSORING PARTICIPATION

The U. S. Department of Agriculture participated in this study according to the Memorandum of Understanding, revised April 15, 1968 among the Economic Research Service, Forest Service and Soil Conservation Service. Leadership of the study was provided by the Soil Conservation Service.

The State of Missouri is the sponsor. Participating state agencies are listed under Acknowledgements. Until the reorganization of state agencies in 1974, the Missouri Water Resource Board coordinated state input. The functions of the board, were then delegated to the Missouri Department of Natural Resources. Agencies which are not in the MDNR participated individually.

ACKNOWLEDGEMENTS

Local, State and Federal agencies with water development program responsibilities provided data, assistance and guidance. Other individuals and groups not listed made contribution to the study.

U. S. Agricultural Stabilization and Conservation Service
U. S. Army Corps of Engineers, Kansas City District
U. S. Bureau of Census
U. S. Bureau of Outdoor Recreation
U. S. Fish and Wildlife Service
U. S. Geological Survey, Surface Water and Topographical Branches
Missouri Department of Agriculture
Missouri Department of Conservation
Missouri Department of Labor and Industrial Relations
Missouri Department of Natural Resources
Missouri Department of Social Services
Missouri Highway Department
Mid-Missouri Regional Planning Commission
Missouri Valley Regional Planning Commission
Lake of the Ozarks Regional Planning Commission
Show-Me Regional Planning Commission
University of Missouri
University of Missouri Extension Service

CHAPTER II

Basin Resources - Economic and Environmental Setting

MAP I
AREAL MAP
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE, MONITEAU, MORGAN, PETTIS, AND SALINE COUNTIES MISSOURI

U. S. DEPARTMENT OF AGRICULTURE

BASIN RESOURCES--
ECONOMIC AND ENVIRONMENTAL SETTING

The use of land, space and water will depend on the importance people attach to conservation and development goals. These goals are often not clear but tend to be reflected in the social and economic forces through the interplay of tradition and institutions. Consequently, a number of factors and processes are involved in the development and conservation of water and land resources. Only some of these can be recognized and measured.

Since the present and future resource uses are tempered by historical use, a brief history is presented on the settlement and its impact on land and water resources. Trends and projections of population, employment, and income are presented to provide guidelines for estimating future water and land needs. Special consideration is given to trends in agricultural and forest resources.

The quantity and quality of water and land resources will determine the physical potential for development and conservation. Therefore, these resources are quantified in order to provide the basic information used to estimate future problems, needs and capabilities.

Since the use of land and water resources will continue to be affected by various land and water programs, the existing resource conservation and development projects and programs that are administered by various local, state and federal agencies are summarized.

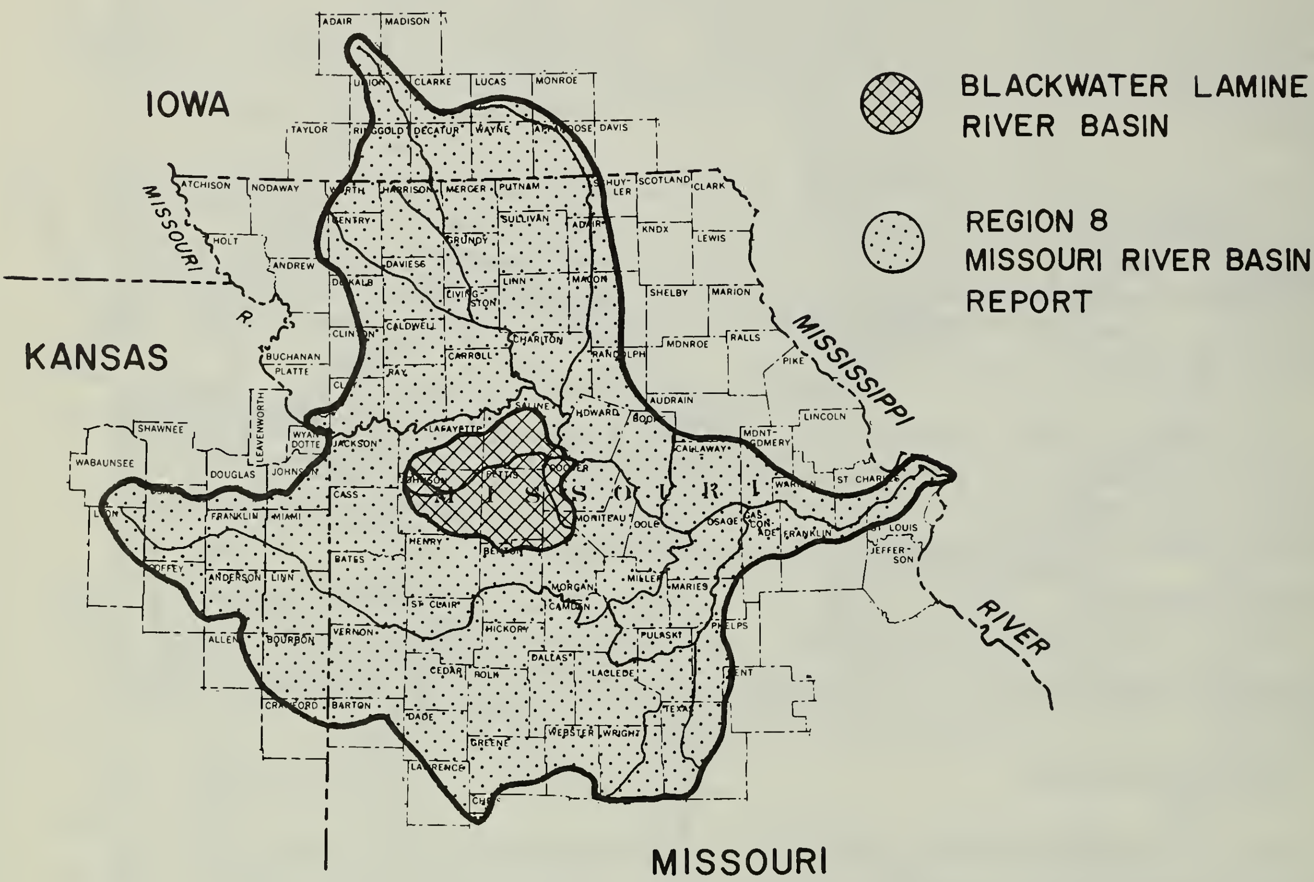
DESCRIPTION

The Blackwater-Lamine River Basin, encompassing 1,702,300 acres or 2659.84 square miles in eight counties, is 3.8 percent of the state, and has an average length of 65 miles and a width of 40 miles (Table 1). It is located south of the Missouri River in west-central Missouri, and is part of Sub-Region 8, Missouri River Basin (Maps 1 and 2). The basin is primarily an agricultural area with a total population of 107,000. Forty-five percent of the population live in the county seats of Sedalia, Warrensburg and Marshall.

Table 1.--County and Subbasin Areas, Blackwater-Lamine River Basin, Missouri.

County	Area in acres			Percent of county area		
	Lamine Subbasin	Blackwater Subbasin	Total Basin	Lamine Subbasin	Blackwater Subbasin	Total Basin
	- - - - - 1000 acres - - - -			- - - - - - Percent - - - - - -		
Pettis	369.5	59.7	429.2	85	14	99
Johnson	25.5	403.1	428.6	5	76	81
Saline	8.2	328.3	336.5	2	67	69
Lafayette	-----	188.3	188.3	--	46	46
Morgan	144.8	-----	144.8	38	--	38
Cooper	104.0	12.2	116.2	29	3	32
Benton	54.3	-----	54.3	11	--	11
Moniteau	4.4	-----	4.4	2	--	2
TOTAL	710.7	991.6	1702.3	--	--	--

Map 2.--Location Map, Blackwater-Lamine River Basin, Missouri in Lower Missouri Subbasin



Interstate Highway 70, traversing the basin from east to west, connects Kansas City, about 25 miles to the west, and Columbia, about 25 miles to the east of the basin. U. S. Highway 50 is a major east-west road going through Warrensburg and Sedalia. Major north-south highways are U.S. 65 connecting Marshall and Sedalia and State Route 13 serving Warrensburg.

The basin divides into two major subbasins, the Blackwater River having a drainage area of 991,600 acres or 1549.33 square miles and the Lamine River having a drainage area of 710,700 acres or 1110.51 square miles.

Most of the Blackwater Subbasin has undulating gently rolling, or rolling topography; but about 15 percent is rolling to steeply rolling and 2 percent nearly level to gently rolling. Mean sea level elevations range from 1080 feet in the headwaters to 580 feet at the outlet. The tributaries, South Fork and North Fork of Blackwater River join to make the Blackwater River. From this junction, it flows in an easterly direction about 76 river miles to the confluence with the Lamine River. Other major tributaries are Post Oak Creek, Clear Creek, Davis Creek and Salt Fork.

The Lamine Subbasin is over 50 percent rolling, steeply rolling or hilly uplands. The remainder is divided almost equally between nearly level to

undulating and gently rolling to rolling topography. Elevations range from 1160 feet mean sea level in the south-west part of the subbasin to 580 feet at the outlet. The Lamine River originates at the confluence of Flat and Richland Creeks. It flows in a northernly direction about 43 miles to its junction with the Blackwater River, then about 10 miles in an easterly direction to the Missouri River west of Boonville. Other major tributaries are Muddy and Heath Creeks.

SETTLEMENT AND HISTORY

Before settlement, the basin was occupied by hunting and fishing parties associated with the Nomadic Indian culture of the Mid-continent. White immigrants started settlements shortly after the return of the Lewis and Clark Expedition in 1804. The early settlements, consisting of only a few families, were located near the streams and progressed upstream from the mouth of the Lamine River, the only convenient access to the interior of the region. Most of these early families migrated from Virginia, Tennessee, Kentucky and Ohio; later, colonies from the central European countries founded communities.

Early descriptions of the basin indicate that the western and northern portions were primarily prairie with forests along the stream valleys and steeper slopes rising to the prairies. These accounts indicate grass fires were one reason for the initial settlement in the wooded valleys. Also, the river and stream bottoms provided convenient construction materials and wild game and fish for food. Many of the settlers were experienced in clearing forest for cropland at their earlier locations. Some historians report that the available plows were primitive which made progress slow in converting the prairie sod to cropland.

Early accounts of flora include hickory, oak, walnut, gum, and other common botton land hardwoods. The fauna present were bear, elk, timberwolves, and beavers; they disappeared about 1850. The presence of buffalo fish, catfish, bass, green sunfish, and paddlefish were noted. By 1850 a reduction in the fishery was recognized.

The settlement was sporadic until the railroad was extended to Sedalia in 1857. The enactment of the Homestead Act in 1862 and the end of the Civil War in 1865 accelerated development. The continued flooding discouraged expansion of river towns and contributed to location of successful population centers in the uplands. Little evidence remains of early river settlements.

Population expanded rapidly during the late 1800's. Early in the 1900's the agricultural revolution and more efficient transportation facilities resulted in migration into the larger cities. Trade centers such as Sedalia, Warrensburg and Marshall grew and prospered while those less favorably located to the transportation system declined or were abandoned.

Prior to settlement, the Blackwater River developed at a geologic rate unaffected by the activities of man. The major streams meandered across the flood plain.

The natural environment was altered during this period of rapid growth and development. Trees were cut for fuel and building material. Sod was plowed and land drained as agricultural production expanded with little

regard to the accelerating erosion. Sediment became a major pollutant affecting the ecological balance of the streams. Changing land to agricultural uses created new habitat conditions for wildlife.

Between 1908-1920, less than 100 years after the settlement of this basin, an association of landowners financed the dredging of a straight pilot channel in the upper reaches of Davis Creek to Lafayette-Saline County line and in North and South Forks of the Blackwater River to a point near the Johnson-Pettis County line. The Blackwater River channels were originally constructed about 12 feet deep and 10 feet wide while Davis Creek, dug with mules and scrapers, was 4 feet deep with a 4 foot bottom. Three channels eroded to a depth of 30-35 feet deep and to widths of over 200 feet. In some locations on Davis Creek the outcropping of bedrock has halted channel degradation, but the channels are still widening. Although these drainage projects provided upstream protection from flooding, they increased sediment production and increased downstream flooding.

Historical records indicate that rock outcrops in the channel began to be buried in about 1920. Today, these same rock outcrops are reported buried with 15 to 20 feet of sediment. The records of the U.S.G.S. stream gage at Blue Lick near U.S. 65 shows the Blackwater River channel has been aggrading since 1920 when the gage was installed. The major deposition occurred before 1946. The flood plain deposition built-up at about the same rate. The channel erosion, sheet erosion and gully erosion produced sediment which provides the material for channel filling and flood plain accretions. The channel degradation in the upper reaches and the aggradation in the lower reaches resulted in an overall reduction of channel fall.

SOCIOECONOMIC CHARACTERISTICS AND PROJECTIONS

The demand for land and water resources is related to several socioeconomic factors such as population, employment and level of income. For example, the demand for soil and water resources in agriculture may be directly related to employment, while the demand for educational services provided by the Central Missouri State University at Warrensburg may be indirectly related to employment. In the first example, the demand for water resource use and development is oriented to agricultural production, whereas in the second example, demand is oriented to housing, recreation, water supply and environmental enhancement. Past trends and projected future levels of socioeconomic factors are presented as guidelines for assessing future water and land resource use and development requirements.

1. Population

The rural nature of the area is reflected by the population density of 40 persons per square miles. This density compares to 68 for the state as a whole and to 1086 for Jackson County which is a part of the Kansas City Metropolitan Area located just west of the basin. About 106,600 people resided in the basin in 1970 (Table 2).

Historically, population increased rapidly in the late 1880's as land was brought under cultivation and the agriculturally based economy grew. With the coming of the agricultural revolution and the expansion of transportation and communication facilities, the population peaked at the turn of the

Table 2.--Population by Counties, 1/ Blackwater-Lamine River Basin, Missouri

County	Total county population	Basin population	Part of county in basin
	- - - - - - - - - number	- - - - - - - -	- - percent - -
Pettis	34,137	34,034	99.7
Johnson	34,172	31,028	90.8
Saline	24,633	21,012	85.3
Lafayette	26,626	12,168	45.7
Morgan	10,068	3,494	34.7
Cooper	14,732	2,873	19.5
Benton	9,695	1,842	19.0
Moniteau	10,742	109	1.0
TOTAL	164,805	106,600	X X

1/ Source: 1970 U.S. Census of Population

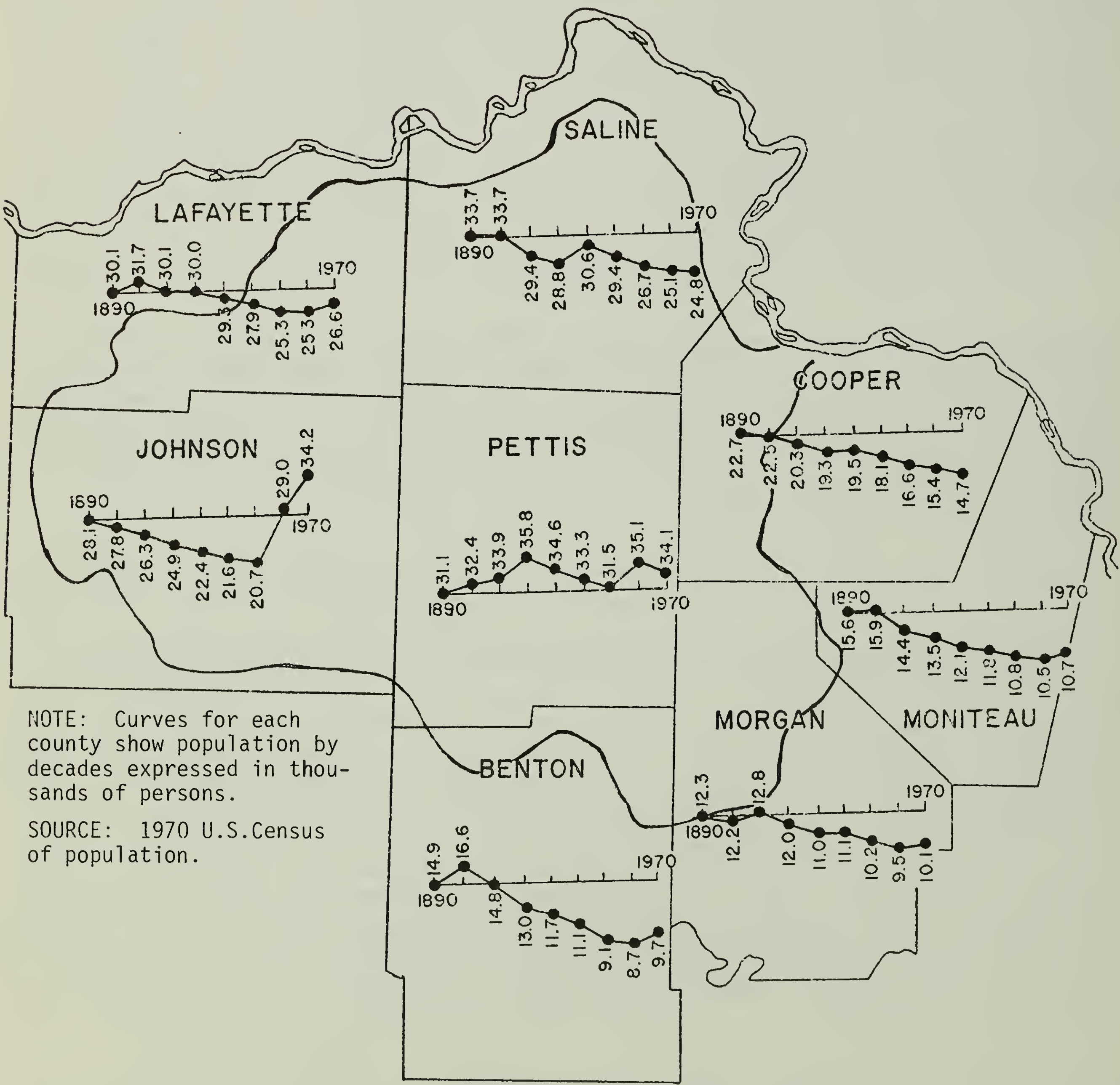
century. Then it declined until about 1950, when this trend reversed and the population again increased (Map 3). Past population trends and projected future growth for the four counties with the largest portions of their populations in the basin are illustrated in (Figure 1). The forces in the four counties causing the upward trend since 1950 are expected to continue and population will probably expand from 119,600 in 1970 to 135,300 by 1980 and to 179,000 by the year 2000.

Since the turn of the century, population has been concentrating in the larger towns, at a constant rate even during periods of declining total population (Figure 2). Three towns with over 10,000 people each, Sedalia, Warrensburg and Marshall, account for 40 percent of the population compared to only 20 percent in the early 1900's. Seven other towns, having populations between 1700 and 5300, comprise 16 percent of the population as compared to 10 percent in the early 1900's. Six percent of the people live in 23 small towns of less than 100 people and the remaining 38 percent live in the unincorporated areas. The three largest cities are expected to attract the majority of people relocating into the area. The forces which established this trend are still operable and the base for expansion of economic growth is well established. All three are county seats and government aid for public services will continue to be furnished to these centers to serve the surrounding areas. Finally, since public and private investments have been made in these three cities, the economic and political interests will probably continue to dominate.

Sedalia, the largest city with a population of 22,847 in 1970, has failed to grow in the past ten years. However, it has a full complement of schools, hospitals, businesses and industries and is expected to be the growth center for the southeastern area in the future.

Warrensburg, with a population of 13,125 in 1970, is the fastest growing city doubling in population from 1960 to 1970. The expansion of Central Missouri State University has been a dominant factor in this growth, and its presence will continue to attract other business and job opportunities to the city. Also, the proximity of Warrensburg to the Kansas City Metropolitan area makes it a prime location for growth as a satellite city.

Map 3.--Population Trends, 1890-1970, Blackwater-Lamine River Basin, Missouri



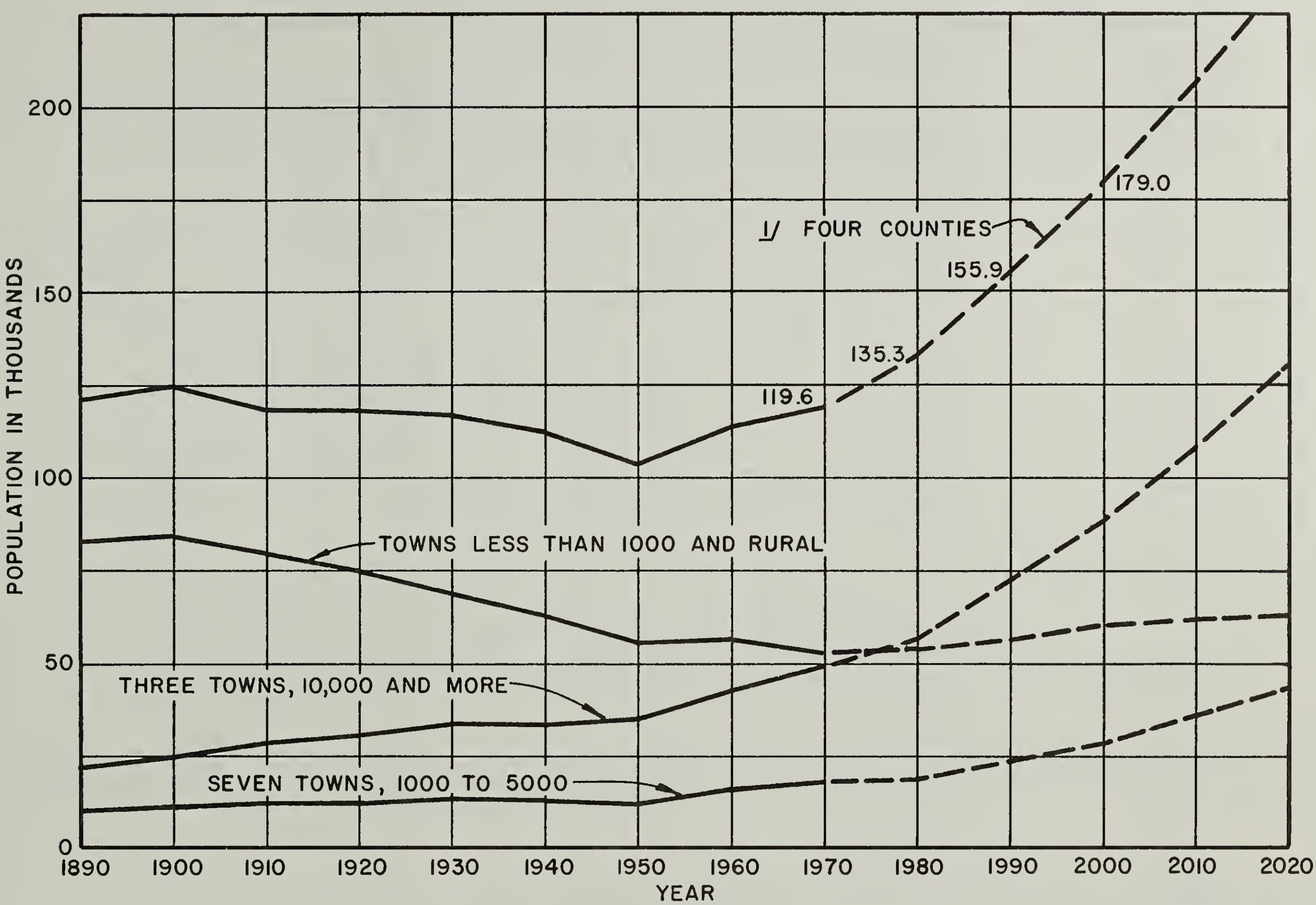
NOTE: Curves for each county show population by decades expressed in thousands of persons.

SOURCE: 1970 U.S.Census of population.

Marshall, with a population of 11,847 in 1970, has had a steady increase in population since 1900 which was caused by a slow but continued expansion of industry and services.

Although economic activity and jobs will continue to be concentrated in and around the three larger cities, smaller towns and rural areas are subject to the pressure of population expansion. Urban sprawl, radiating from Kansas

Figure 1.--Population Trends and Projections, Four Major Counties 1/, Blackwater-Lamine River Basin, Missouri

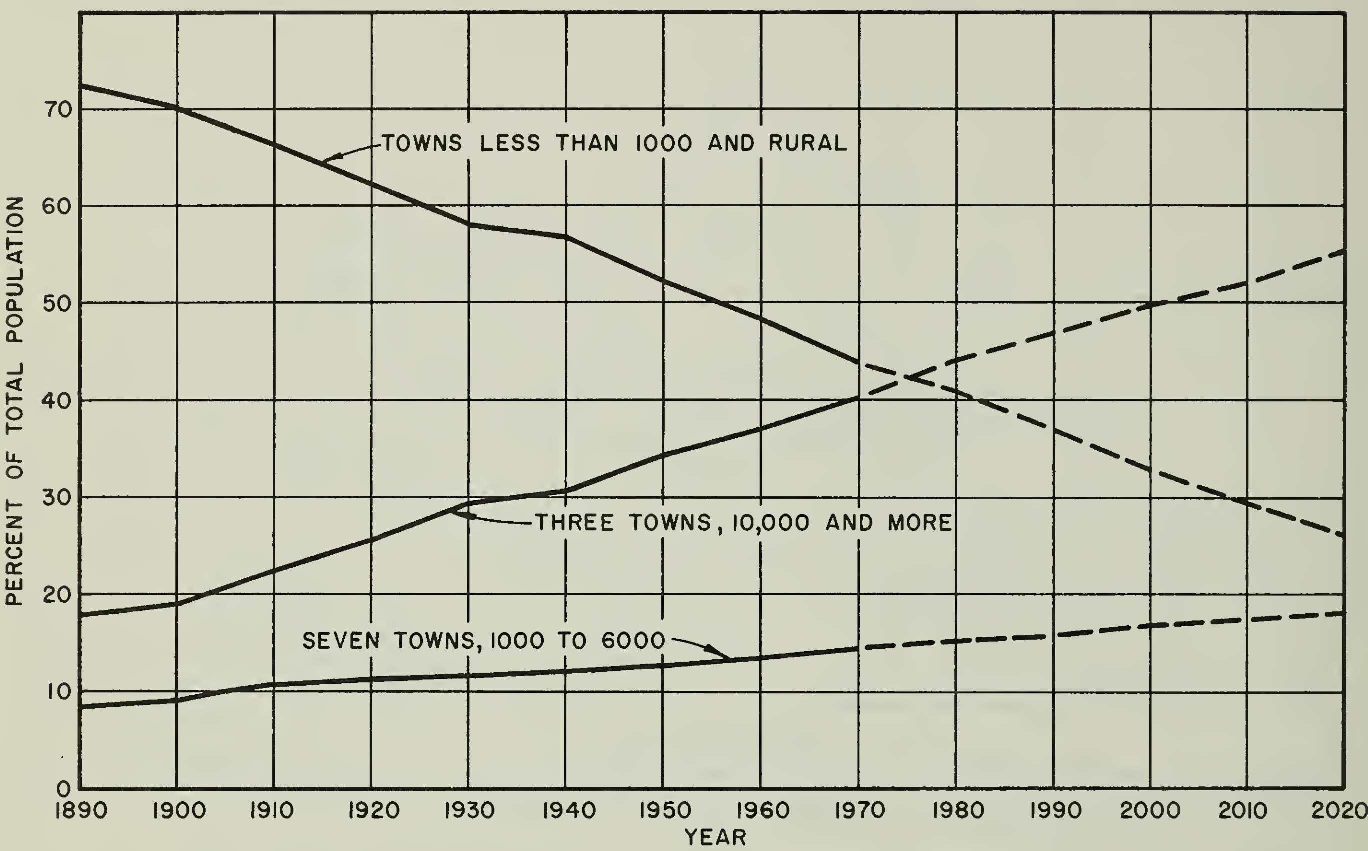


1/ Johnson, Lafayette, Pettis and Saline Counties. Projections from State of Missouri

City, is already noticable in small towns and rural areas in the western part of the basin. Land is being subdivided into small plots of a few acres. All of the attendant problems associated with this expansion are already being felt. Decisions made at the local level regarding public and private utilities and services, planning and zoning, and environmental and health considerations will strongly influence the future population location. However, the demand for development is strong and population density will increase whether in concentrated communities or more extensive small farms. Also, some of the smaller towns such as Sweet Springs and Concordia will grow because of their strategic locations on Interstate 70.

Another recent development that will have an economic and environmental impact is the increased interest in rural lands for second homes and for recreational, sporting or environmental use. Areas with unique landscapes, particularly those with potential reservoir sites, forested land, or natural streams will be prime targets for these uses. Although the owners would continue to live in their present location, which might be outside the basin, they would have an interest in resource use and economic growth of the basin.

Figure 2.--Population Distribution by Years, Four Major Counties 1/,
Blackwater-Lamine River Basin, Missouri



1/ Johnson, Lafayette, Pettis and Saline Counties.

2. Employment

The availability of jobs in the basin or within commuting distance is the critical factor that will determine whether the population increases to the extent projected. The four major counties Johnson, Lafayette, Pettis and Saline were used as representing the basin for the purpose of describing past and present employment and projecting future employment. Ninety-five percent of the labor force was employed in 1970. Unemployment has not exceeded five percent on an annual basis in the past few years because the economy of the area has been growing and also because jobs within commuting distance have been available. Employment in the basic activities of mining, manufacturing, agriculture and forestry accounted for about a third of the work force. Jobs in non-basic activities accounted for two-thirds (Table 3). Metal Fabrication, food and kindred products, apparel and textile products and transportation equipment are the primary items manufactured. Most of the manfacturing plants are located in the three cities with populations over 10,000.

The non-basic industries including construction, sales, utilities and services are indirectly related to the basin industries. However, Central Missouri State University and Whiteman Air Force Base are exceptions. Jobs in these two facilities are not directly related to the basic industries, because, they supply demands from outside the basin.

Table 3.--Employment by Industry Group, Four Major Counties, 1/. Blackwater-Lamine River Basin, Missouri, 1970 2/.

Item	Number of workers	
	Number	Percent
Civilian labor force employed	43,926	95.0
Civilian labor force unemployed	1,816	5.0
Total labor force	45,742	100.0
Basic Activities:		
Agriculture and forestry	5,297	12.1
Mining	145	0.3
Manufacturing:		
Metal industries	(1,489)	(3.4)
Food and kindred products	(1,472)	(3.4)
Apparel and textile products	(1,236)	(2.8)
Transportation equipment	(1,057)	(2.4)
All other	(4,014)	(9.1)
Subtotal	9,268	21.1
Total Basic	14,710	33.5
Nonbasic Activities:		
Construction	2,603	5.9
Transportation, Communications & Utilities	2,609	6.0
Wholesale trade	1,175	2.7
Retail trade	7,206	16.4
Finance, Insurance & Real Estate	1,412	3.2
Services including government	14,211	32.3
Total Nonbasic	29,216	66.5
Total Employment	43,926	100.0

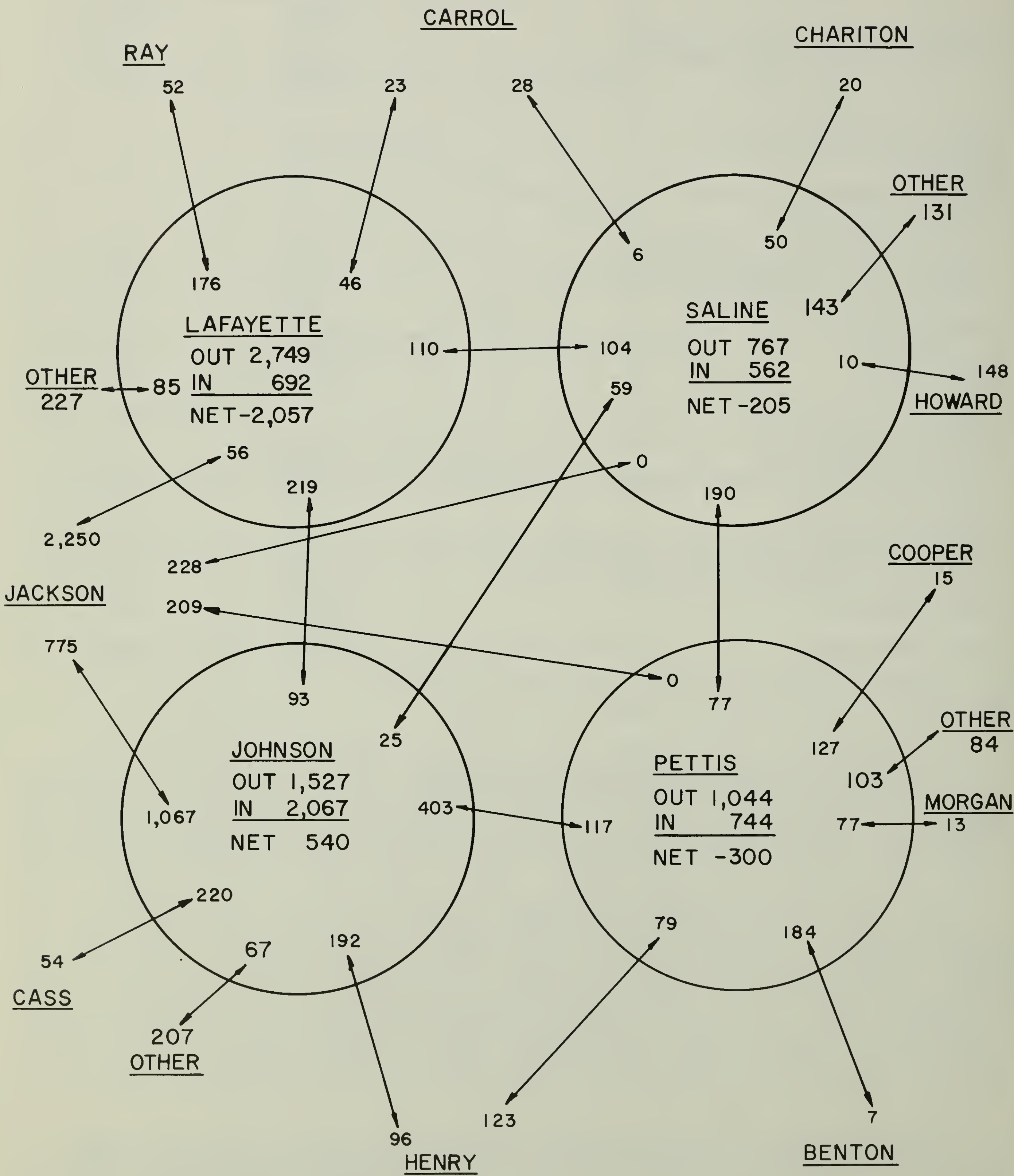
1/ Johnson, Lafayette, Pettis and Saline Counties.
2/ Source: U.S.Census of Population, 1970.

The amount of commuting to jobs in another county increases jobs in non-basic activities beyond the supportive secondary role (Figure 3). In 1970, only 77 percent of the people in the four county area worked in the county in which they lived. Commuting is especially high in Lafayette County where 35 percent of the employed people travel outside the county to their jobs.

The 3,462 workers regularly commuting into the Kansas City area of Jackson County is partly offset by the commuting into the basin from the other counties. For example, the 2,067 workers coming into Johnson County is 540 more than the 1,527 traveling outside the county to work. However, in Lafayette, Pettis and Saline Counties, more people work out of these counties than come in from the surrounding area. Thus, the basin population is larger because more people commute to jobs outside than those commuting to jobs inside the basin.

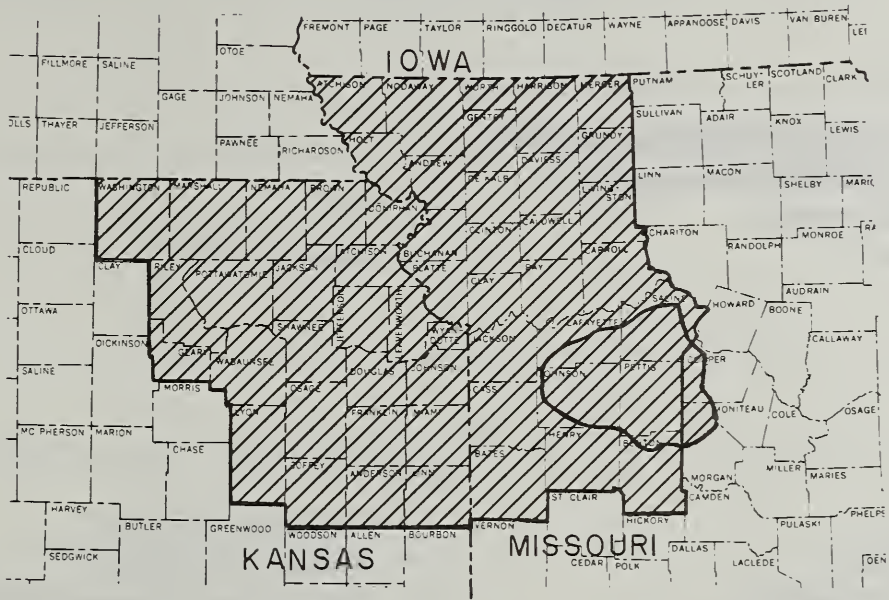
Because of the interrelationships between the basin and the surrounding area, the Bureau of Economic Analysis Economic Area 111 employment projections were used as guidelines to project employment of each industry category for the four county area. Economic Area 111 includes 52 counties in Kansas and Missouri centering around and including Kansas City (Map 4).

Figure 3.--Employment Commuting Into and Out of Four Major Counties, Blackwater-Lamine River Basin, Missouri 1970 1/



1/ Source: 1970 U.S. Census of Population

Map 4.--BEA Economic Area 111, Blackwater-Lamine River Basin, Missouri



Correlations of past employment in the four county area with employment in the larger BEA area were a basis for projecting the future mix of employment by categories.

Although the direction of change in employment in each category is the same in the BEA area as it is in the four county area, the mix is different (Figure 4). For example, while employment in agriculture has declined in both areas, it remains relatively high in the basin. Also the percentage of workers in manufacturing has increased at a faster rate in the basin area. In general, employment in non-basic activities comprises a smaller portion of total employment in the four county area than in the BEA area. In the future the percent of workers employed in agriculture will continue to decrease, while employment in manufacturing and services will continue to increase for both the four county area and BEA Area 111 (Figure 5).

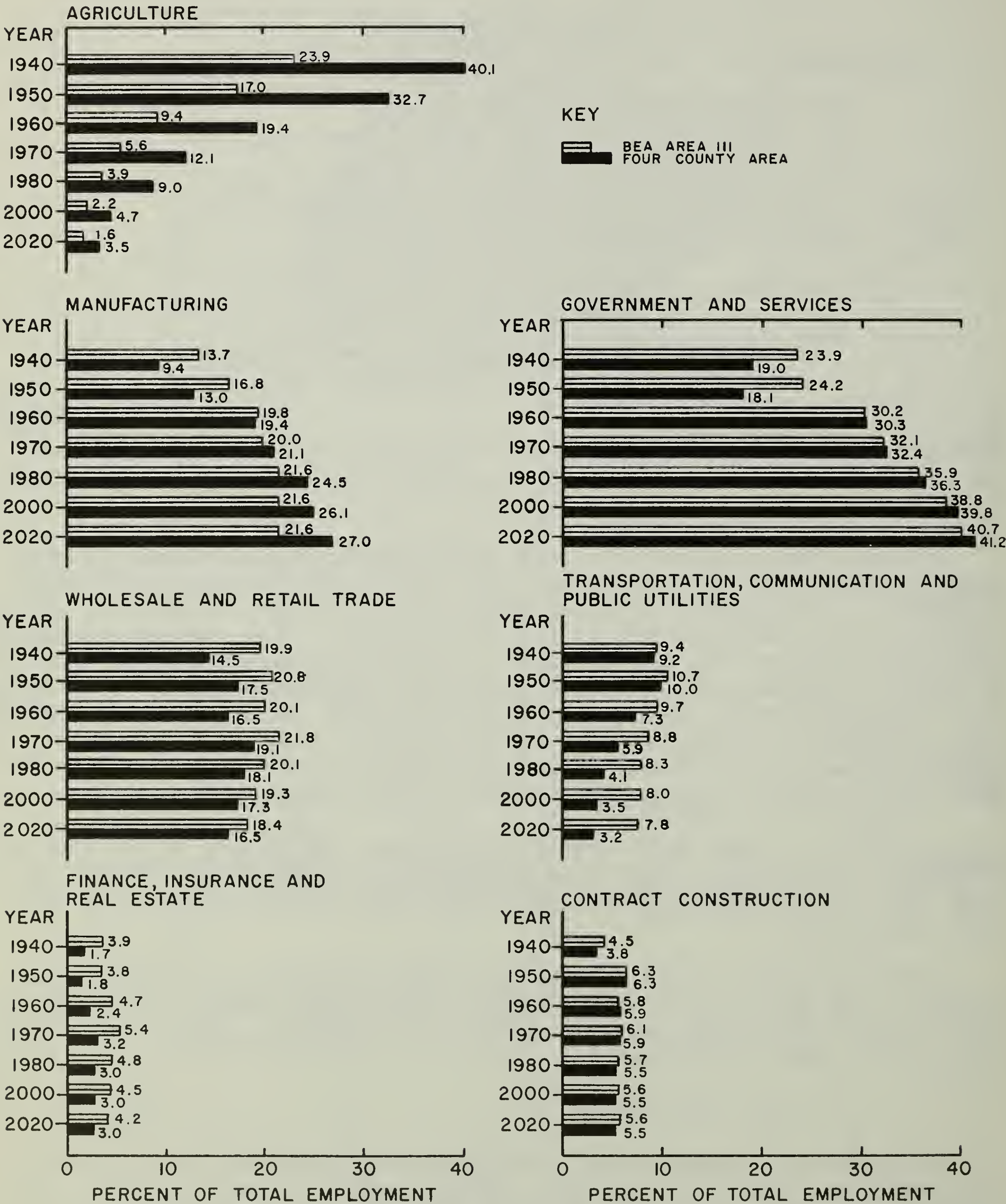
The percent of the total population employed was assumed to continue at 40 percent. Employment in services, manufacturing, and wholesale and retail trade will be the largest gainers while employment in agriculture will continue to decrease.

Total employment in the four county area is expected to increase from 43,900 in 1970 to 52,900 in 1980, 71,600 in 2000 and 95,300 by the year 2020. This increase will be necessary to sustain the population projections anticipated by the State of Missouri.

3. Income and Earnings

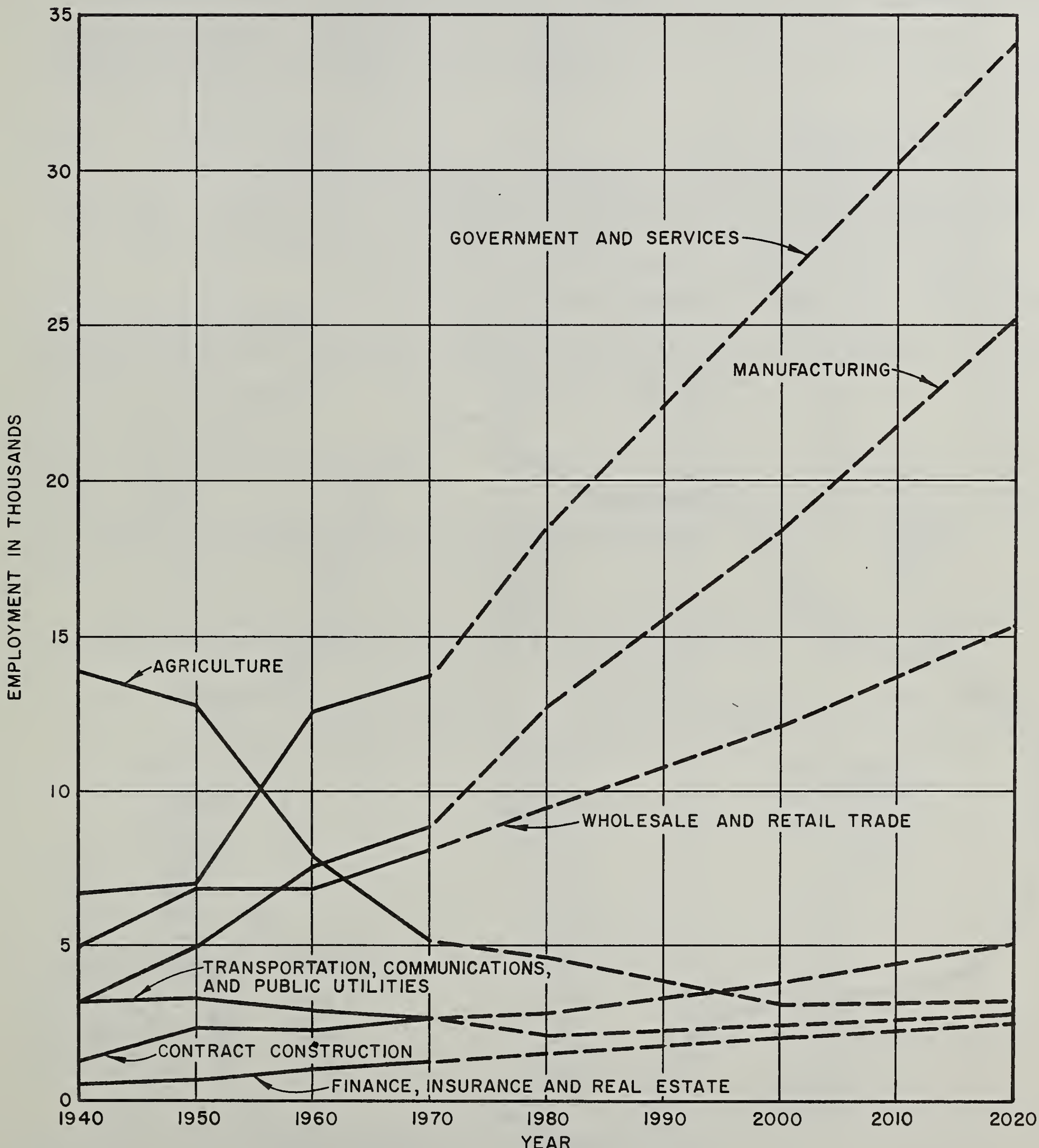
Income levels are below the state average but above the state average for rural areas (Table 4). In 1970, the mean annual income for families was $8,818; the median was $7,618. About 12 percent of the basin families have incomes below what is considered the poverty level compared to 11.5 percent for the state as a whole and 16.7 percent for all rural farm areas in the state. The average family income by counties decreases from northwest to southeast across the basin (Figure 6). The percent of families with income

Figure 4.--Trends and Projections of Percentage of Employment by Categories, BEA Area 111 and Four Major Counties 1/ Blackwater-Lamine River Basin, Missouri



1/ JOHNSON, LAFAYETTE, PETTIS AND SALINE COUNTIES.

Figure 5.--Employment Trends and Projections by Major Industries, Four Major Counties, 1/ Blackwater-Lamine River Basin, Missouri



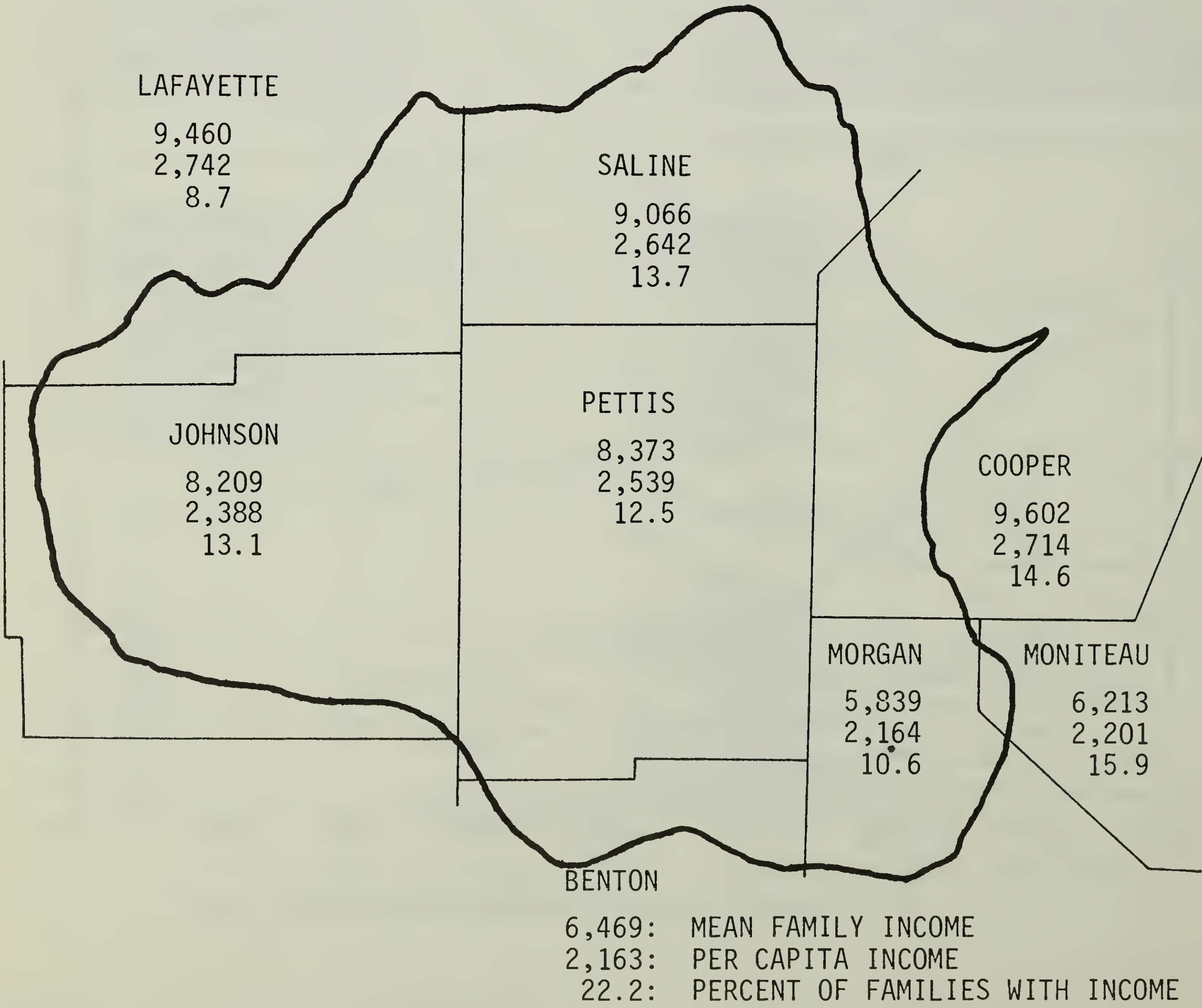
1/ JOHNSON, LAFAYETTE, PETTIS AND SALINE COUNTIES.

Table 4.--Family Income, Four Major Basin Counties, Rural Farm, Rural Nonfarm and State. Blackwater-Lamine River Basin, Missouri 1970

Family income	Four major basin counties 1/	State of Missouri: Rural farm	State of Missouri: Rural nonfarm	State of Missouri: Total state
	- - - - - - - - -	dollars	- - - - - - - - - -	
Mean	8,818	7,926	8,080	10,236
Median	7,618	6,414	7,172	8,914
Per capita	2,566	2,369	2,338	2,964
Percent of families with less than poverty level 2/	12.1	16.7	12.7	11.5

1/ Johnson, Lafayette, Pettis, and Saline Counties.
2/ The poverty level varies by age and composition of the family. The average poverty threshold for a nonfarm family of 4, headed by a male was $3,745. The average for a farm family was $3,195.
Source: 1970 U.S. Census of population.

Figure 6.--Average Family and Per Capita Income, By County, Blackwater-Lamine River Basin, Missouri 1970



SOURCE: 1970 CENSUS OF POPULATION

less than poverty level increases in a similar pattern from a low of 8.7 percent for Lafayette County to a high of 22.2 percent for Benton County. This pattern reflects a number of factors including the availability and accessibility to growth centers for commuting to jobs, the agricultural productivity of the county and the average age of population.

Eighty percent of the basin families receive some income from wages and salaries compared to 84 percent for the State of Missouri (Table 5). A higher percent of families in the basin than in the state receive social security, or are self employed in agriculture.

Table 5.--Family Income by Type, Four Major Counties and State of Missouri. Blackwater-Lamine River Basin, Missouri 1970.

Item	Four Major Counties 1/		State of Missouri	
	Percent of all families	Mean income	Percent of all families	Mean income
Type of family income	percent	dollars	percent	dollars
Wage or salary	80	7,803	84	9,553
Nonfarm, self employed	13	6,260	11	7,363
Farm, self employed	19	3,721	9	3,128
Social security	24	1,740	22	1,620
Public assistance or welfare	4	917	5	1,044
Other income	29	1,847	33	2,259

1/ Johnson, Lafayette, Pettis and Saline Counties.
Source: 1970 U.S. Census of Population

The distribution of family income by income group shows that 58.5 percent have incomes between $4,000 and $12,000 (Table 6).

Table 6.--Family Income Distribution, Four Major Counties, 1/ Blackwater-Lamine River Basin, Missouri 1970

Family income level	Families	Percent distribution
dollars	number-	percent
Less than 2000	2,139	6.9
2000 to 3999	4,411	14.3
4000 to 5999	4,853	15.7
6000 to 7999	5,040	16.3
8000 to 9999	4,585	14.9
10,000 to 11,999	3,572	11.6
12,000 to 14,999	2,960	9.6
15,000 to 24,999	2,510	8.1
Over 25,000	788	2.6
Total	30,858	100.0

1/ Johnson, Lafayette, Pettis and Saline Counties.
Source: 1970 U.S. Census of Population.

Industrial earnings in the four major counties are not directly comparable to area employment data because of commuting from one county to another (Table 7). However, these data show the major changes in earnings across

Table 7.--Distribution of Industrial Earnings, Four Major Counties, 1/ Blackwater-Lamine River Basin, Missouri

Type of earnings	Year 1929	1940	1950	1959	1970
	- - - - - - - percent distribution - - - - - - -				
Farm	28.6	28.8	34.8	20.4	20.6
Government	5.1	13.4	7.1	20.3	26.4
Manufacturing	9.8	7.7	10.2	13.0	14.3
Mining	1.6	2.0	.5	.4	.4
Contract construction	8.9	3.9	10.5	11.2	6.6
Transportation, communication, and public utilities	19.2	20.3	14.5	7.5	4.3
Wholesale and retail trade	11.2	12.0	13.2	14.9	14.1
Finance, insurance and real estate	3.1	2.2	1.9	3.0	2.4
Services	12.4	9.5	7.0	9.0	10.4
Other	.1	.2	.3	.3	.5
Total	100.0	100.0	100.0	100.0	100.0

1/ Johnson, Lafayette, Pettis and Saline Counties.
Source: Bureau of Economic Analysis.

the broad industrial sectors. Farm earnings, as well as earnings from mining, construction, transportation, communication and utilities are decreasing in importance while earnings in government, manufacturing and trade are increasing.

4. Agricultural Trends

Several factors determine the use of land and water and the extent to which these resources will be conserved and developed. Since most of the land is owned by farmers, goals will be the most important factor in applying a conservation and development program. Therefore, the historical agricultural production, the future prices for farm products and farm inputs, the technological advances, the tenancy of the operator, the full or part-time status of the operator, and the age of the operator all will play a role in the adoption of conservation and development programs.

Agricultural operations vary from a partly retired farmer with a few cattle and a garden or a part-time farmer with a full-time job elsewhere to a large full-time commercial farmer. In 1969, seven percent of the farmers were partly retired, 17 percent part-time and 76 percent were commercial farmers with sales of farm products of 2,500 dollars or more (Table 8).

Although only three-fourths of the farms are classified as commercial, they accounted for 89 percent of the agricultural land, 98 percent of the value of farm products sold and 91 percent of the government payments received in 1969. These farms averaged 296 acres in size as compared to about 100 acres for all other farms.

Part-time farmers supplement their income by working off their farms. The percent of farmers working at other jobs has increased steadily since 1959. In 1969, half of all farmers worked on other jobs while 36 percent

Table 8.--Trends in Farm Characteristics, Four Major Counties, 1/ Blackwater-Lamine River Basin, Missouri

	Unit	Year 1959	1964	1969
Total farms	Number	8,267	7,321	7,302
Land in farms	1000 acres	1,666	1,663	1,710
Type of farm:				
Commercial	Percent	73	71	76
Part-time	Percent	16	16	17
Part retirement	Percent	11	12	7
Average size of farms	Acres	203	227	234
Operator working off farms:				
Total working off farms	Percent	40	42	51
Working 100 days or more	Percent	26	29	36
Income from sales of products:				
Livestock products	1000 dollars	48,191	47,763	76,068
Crops	1000 dollars	18,385	18,241	22,202
Forest and horticultural	1000 dollars	229	245	103
TOTAL	1000 dollars	66,805	66,249	98,373
Value per farm	Dollars	8,081	9,049	13,472
Value per acre	Dollars	40	40	58
Quantity of product sold:				
Cattle and calves	1000 head	143	160	188
Hogs and pigs	1000 head	523	546	615
Milk	Mil. lbs.	138	132	n.a
Eggs	1000 dozen	8,806	4,195	n.a
Chickens	1000	820	334	623
Sheep and lambs	1000 head	33	12	10

1/ Johnson, Lafayette, Pettis and Saline Counties.
Source: Census of Agriculture.

worked at other jobs 100 days or more during the year.

The average age of farm operators in the area is 52 years, the same as for the state. Only 30 percent of the farmers are less than 45 years old, which is also true for the state.

Farmers have major investments in land, buildings and machinery. In 1969 the average commercial farmer had $79,084 invested in land and buildings or about $268 per acre while all farmers averaged $63,446 and $270, respectively. Machinery investment averaged $11,414 per farm or $37 per acre for commercial farmers. These investments have increased significantly since 1969.

Income from the sale of farm products amounted to about $98 million in 1969 or about $13,500 per farm or $58 per acre. Sales of livestock products accounted for 77 percent of the income from farm sales while crops accounted for 23 percent.

The sale of cattle provides nearly half of the livestock income. These sales are primarily from cow-calf operations, but one-third are from fattened cattle. One reason for the cow-calf type of operation is that it requires

less labor which appeals to the part-time farmer. Hogs are the second most important source of livestock income, amounting to 25 percent of the total livestock income. Dairy farming accounts for about eight percent and other poultry and livestock products for remaining 17 percent. Marketing of cattle and hogs have both increased during the past 10 years while milk, poultry and sheep products have decreased.

In addition to income from the sale of farm products, farmers in 1969 received about $8.0 million in government payments for farm programs, $1.1 million for farm-related agricultural services and $45,000 for farm recreational services. More recently, government payments have decreased and farm income from the sale of products has increased as farmers responded to the policy of expanding agricultural production.

Purchases of farm supplies and services for agricultural production contributes significantly to the economy of the basin (Table 9).

Table 9.--Selected Farm Costs, Four Major Counties, 1/ Blackwater-Lamine River Basin, Missouri 1969.

Item	Cost
	1000 dollars
Feed purchased	16,677
Livestock and poultry purchased	12,794
Fertilizer and lime	6,208
Gas, oil, and fuel	4,256
Agricultural chemicals	1,542
Hired labor	2,944
Custom machine and labor	2,281
Seed and plants	1,816

1/ Johnson, Lafayette, Pettis and Saline Counties.
Source: 1969, Census of Agriculture

Consistent with a national trend, the number of farms is decreasing while the average farm size, gross farm income, and farm investments are increasing. A higher proportion of farmers are working off their farms. These trends reflect the rapid adoption of technology and the replacement of labor with capital that has been occurring for several years. The effects of recent scarcities of energy and fertilizer are not yet reflected in these data. Both could have a significant impact on costs and total production of agricultural products.

5. Projected Demand for Food and Fiber

Land and water are the basic resources for agricultural and forestry production. The need for resource development will depend upon the demand for food and fiber. Since food and fiber products from the basin are sold on national markets, the future demand will be determined from outside the basin.

Baseline projections of requirements for agricultural and forestry products from the basin were estimated for the years 1980, 2000 and 2020. These are consistant with the OBERS "E" Projections for Water Resource Planning Area 1030. The major factors considered in the projections were:

1) population growth; 2) per capita disposable income; 3) consumer tastes and their influence on per capita consumption; 4) industrial and other uses of agricultural and forestry commodities; and 5) exports and imports. 1/

Trends in production and projected baseline requirements for the major crops are shown (Figure 7). Corn production is expected to increase gradually at about the same rate as in the past. Soybeans, a relatively new crop to the area, are expected to be more important in future markets; production is expected to increase to 184 percent of current levels by 1980 and to 226 percent by the year 2000. Sorghum production is also expected to increase rapidly. Wheat production will not expand greatly and the production of oats will continue to decline.

The basin area is expected to produce its same share of livestock products as in the past. More hay and pasture will be required to satisfy the increased demand for livestock products. Hay production must increase 16 percent by 1980, 41 percent by 2000 and 98 percent by 2020 to supply the expanding livestock requirements. Similar production increases are needed in pasture.

The production of forest products in the past has been variable because of fires, insects, diseases, markets, and changing land use patterns. Since forested areas are owned predominantly by farmers, the forest land has often been considered a source of posts, lumber, fuel and other products required on the farm itself. Only occasionally has it been managed for the sale of forest products. Typically, timber was sold as a by-product of clearing operations.

The development of a pulpwood market in recent years provides an incentive for increasing forest production. Projections of demand for pulpwood indicate that this market could accomodate a much larger volume of production from the basin in the future (Figure 8). This demand is expected to increase nearly 13 times the 1970 level by the year 2020. The demand for sawlogs and fuelwood is not expected to change significantly in the future.

The projected demand for food and fiber were used as guidelines to assess the capability of the land and water resources of the area with and without resource development.

NATURAL RESOURCES BASE-DESCRIPTION, DEVELOPMENT AND USE

An understanding of the potential and limitations of the resource base is a necessary prerequisite to planning resource development. The present development and use is included to show current availability of these resources. The inventory of the present use of land and water resources provides information that will facilitate decisions which will guide future resource use. It provides a base from which to view future demands for resources and possible conflicts in use. In the process, choices are being and will continue to be made between conflicting uses. Limits on the use and development of natural resources will be established.

1/ OBERS "E" Projections, Regional Economic Activity in the U.S., U.S. Water Resource Council, Washington, D. C., 1972.

Figure 7.--Historical and Projected Production for Major Crops, Blackwater-Lamine River Basin, Missouri

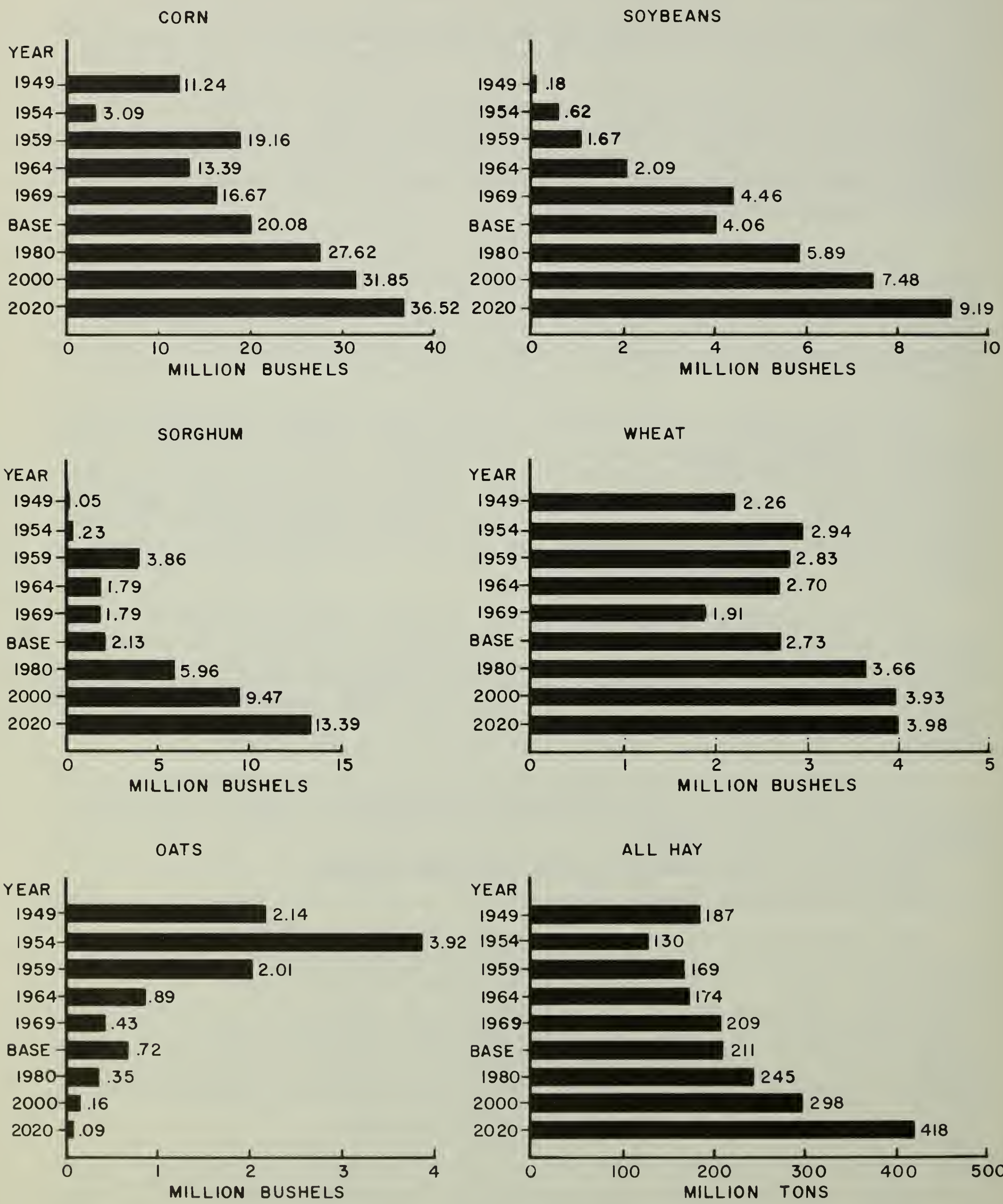
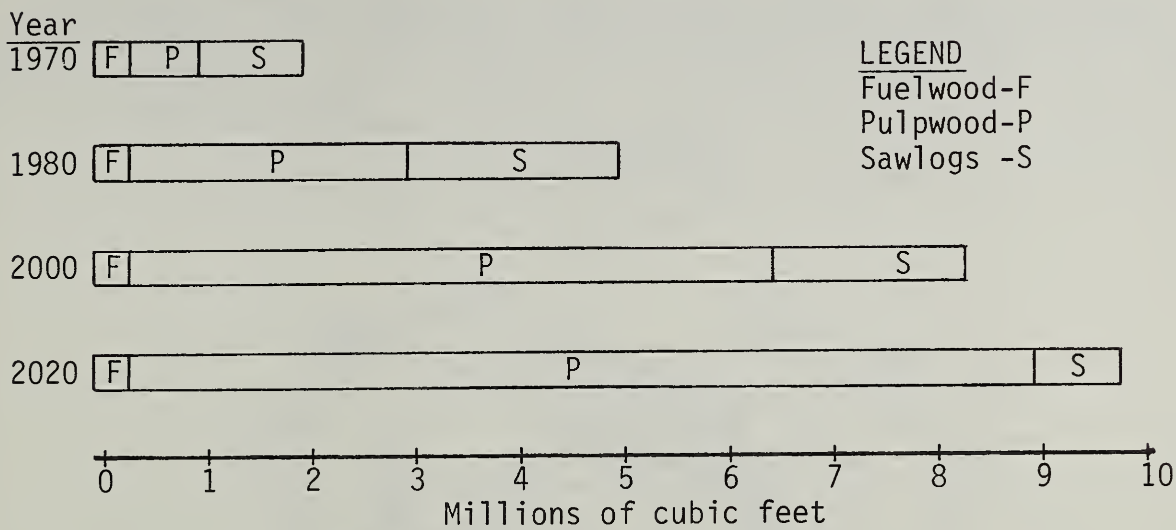


Figure 8.--Demand of Timber Products, Blackwater-Lamine River Basin, Missouri



The potential for resource development and conservation depends upon the quantity and quality of land, water, and related resources. Climatic and soil factors determine the kind of agricultural and forest products that can be commercially raised. The quantity and quality of ground water is partially determined from the underlying geologic formations. The suitability of a site for buildings, roads, dams and other engineering structures depends to a large extent upon the geology and soils. Agricultural and forestry productivity, recreation suitability, game habitat, erosion and pollution susceptability are related to the type of soils.

1. Climate

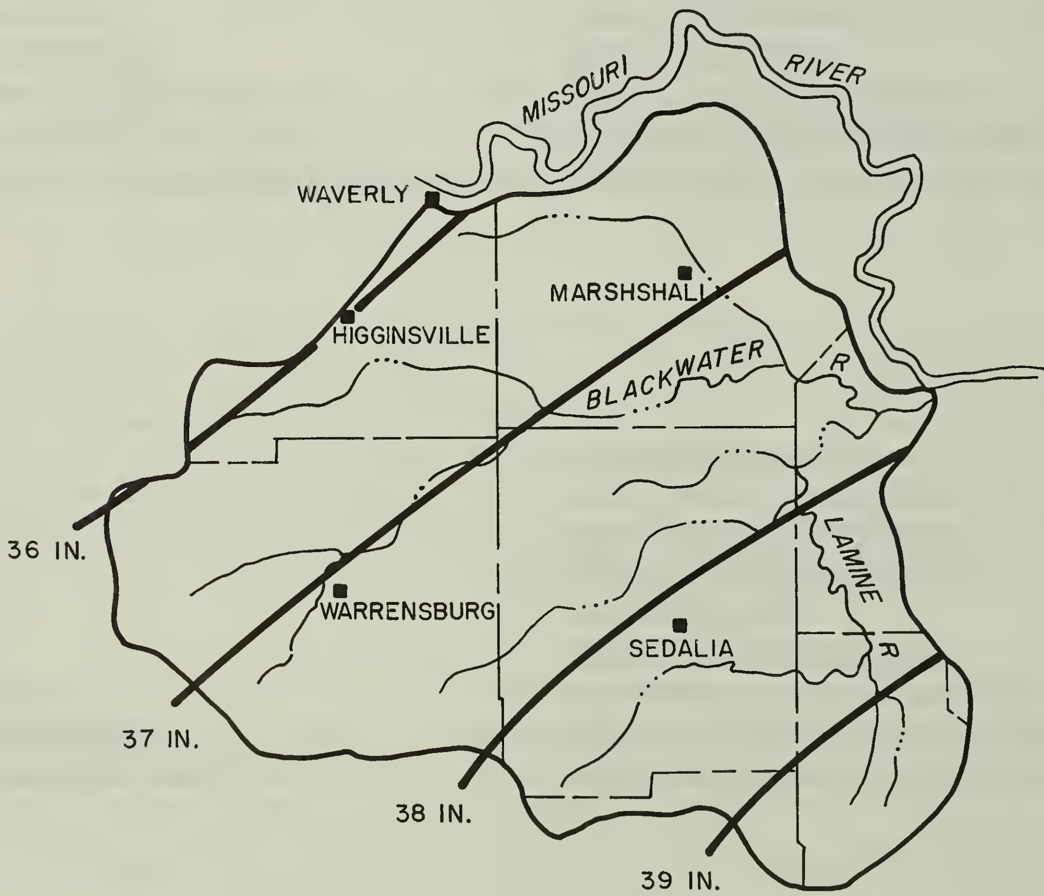
The basin is in the humid climatic zone. Large variations in temperature and precipitation occur annually. In Kansas City, summertime relative humidity will range from 50 to 80 percent over a 24 hour period. Mean monthly relative humidity varies from 64 to 72 percent while the yearly average is 65 percent. Winters are cold with January having a mean temperature of 31.5 degrees Fahrenheit. Temperatures can be as warm as 50 degrees Fahrenheit in January and February but periods of zero temperatures occur most years. During July and August temperatures approach 100 degrees or more for a few days in most years.

The mean annual temperature at Sedalia is 56.5 degrees Fahrenheit. The mean growing season temperature is 68.3 degrees Fahrenheit. The extreme measured temperatures at Sedalia were a -16 degrees Fahrenheit in 1943 and 116 degrees Fahrenheit in 1954. The average frost-free period of 192 days extends from mid-April through late October. At Sedalia the latest killing frost of record in the spring was on May 3, and the earliest killing frost in the fall was October 9.

Prevailing winds are from the south-southwest and average 9 to 12 miles per hour. Velocities in excess of 70 miles per hour sometimes occur during thunderstorms.

Flood producing storms of the frontal type occur any month of the year. Thirty-six percent of the annual rainfall occurs in April, May, and June, while the reamining 64 percent is distributed throughout the other nine months. Average annual precipitation varies from less than 36 inches near Higginsville to more than 39 inches in the southern part of the basin (Map 5).

Map 5.--Average Annual Rainfall-Inches, Blackwater-Lamine River Basin, Missouri



The annual rainfall recorded at the Sedalia gage ranges from a maximum of 60.19 inches in 1969, to a minimum of 22.15 inches in 1956. The average monthly rainfall at the Sedalia gage varies from 1.57 inches to 5.11 inches (Table 10).

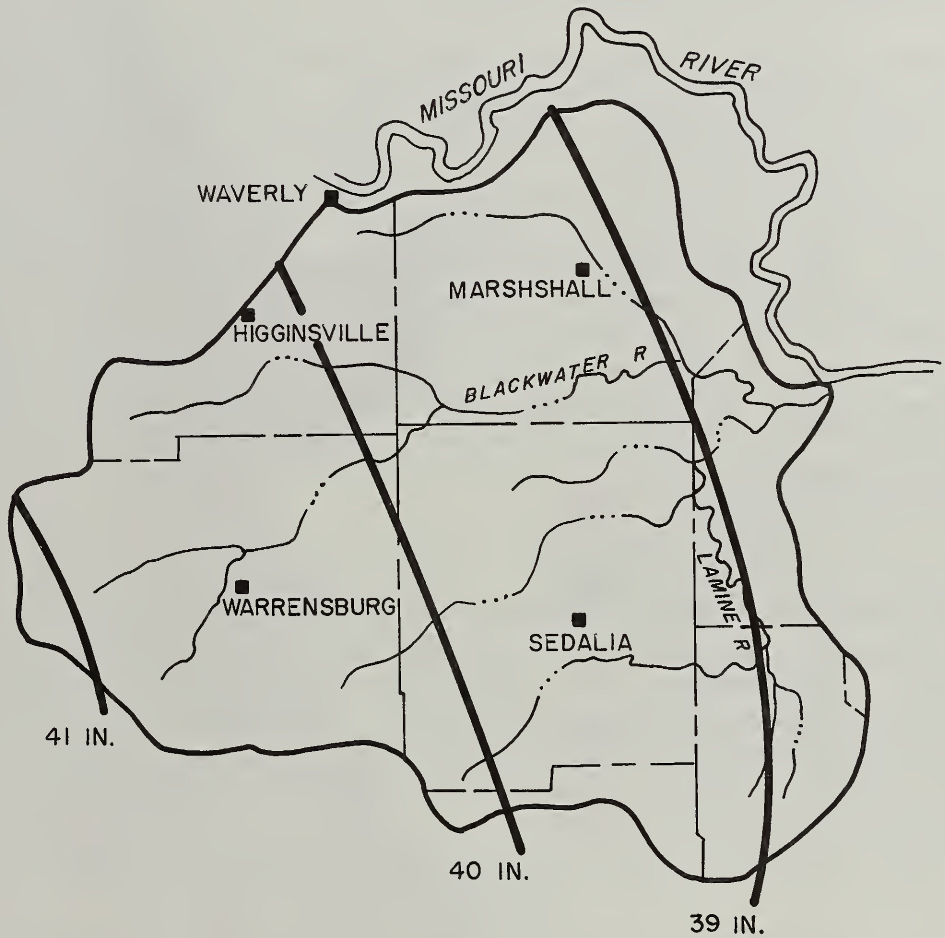
Table 10.--Average Monthly Rainfall at Sedalia, Blackwater-Lamine River Basin, Missouri

Jan.	1.57"	April	4.23"	July	4.01"	Oct.	3.85"
Feb.	1.72"	May	5.11"	Aug.	3.85"	Nov.	2.16"
March	2.57"	June	4.98"	Sept.	4.22"	Dec.	1.81"

On the average, 72 percent of the rainfall occurs from April through September. Droughts of 4 to 6 weeks duration often occur in the summer.

Lake evaporation varies from year to year but averages range from 39 to over 41 inches per year (Map 6). Some factors effecting evaporation are wind movement and temperatures. Seventy-six percent of the evaporation occurs from May through October.

Map 6.--Average Annual Lake Evaporation-Inches, Blackwater-Lamine River Basin, Missouri



2. Geologic Resources

a. General Geology

The Blackwater and Lamine Rivers drain the northeastern sector of the Osage Plains and the northwestern sector of the Salem Plateau (Ozarks) physiographic regions, respectively. Terrain is considerably smoother in the Blackwater River Subbasin than in the Lamine River Subbasin. Paralleling this difference in terrain is a difference in fall of streams in the two subbasins. The Blackwater River rises at elevations of just over 1080 feet and enters Lamine River at an elevation of about 580 feet; Lamine River rises at elevations in excess of 1160 feet and enters the Missouri River at an elevation of about 580 feet. Thus, the Blackwater River and its upper tributaries

fall about 490 feet, while the Lamine River and its upper tributaries fall about 570 feet in a shorter distance.

Geologic differences between the two subbasins are distinct (Map 7). The oldest rocks which outcrop in the area are dolomites (calcium-magnesium carbonates) which underlie most of the headwaters region of Lamine River and are exposed along the middle course of this stream in a narrow outcrop belt. These rocks occur in a nearly flat-lying strata inclined at a very low angle toward the north and northwest. This inclination causes the older dolomite strata to dip beneath younger, different rocks to the north and northwest. Thus, thick-bedded limestone is the uppermost bedrock in areas immediately north and northwest of the dolomite area.

In the western part of the basin, the limestone strata dips beneath younger rocks of strikingly different character. These are a sequence of interbedded shales, sandstones, limestones, and coals which display a cyclic repetition of the several kinds of rock in relatively thin beds. The cyclic deposits are separated into an upper group (Marmaton) and the lower group (Cherokee). The upper sequence has relatively little coal but important limestone beds. The lower sequence contains most of the coal beds but no commercially significant limestone (Figure 9). Sandstone, which fills an ancient channel incised into the cyclic deposits, forms a fifth major division of the bedrock. A sixth division consisting of limestone is present along the upper valley walls of Muddy and Shaver Creeks and the Lamine River in Cooper County. It is limited in extent and is included with the thin to medium bedded carbonates.

b. Mineral Resource

Mineral resources within the basin include fossil fuels, metals, and non-metals. Mineral commodities which have been commercially produced include barite, clay, shale, coal, lead, zinc, sand, gravel, and stone. In recent years only stone has been of economic importance. The annual value of mineral production for the 20-year period 1952 through 1971 has ranged from a low of $833,000 in 1956 to a high of $2,806,000 in 1963 (Table 11).

Table 11.--Annual Mineral Production Value 1/, Blackwater-Lamine River Basin, Missouri

Year	Value Thousand	Year	Value Thousand
1952	$ 1,377	1962	$ 2,644
1953	1,876	1963	2,806
1954	1,306	1964	2,363
1955	1,472	1965	2,574
1956	833	1966	2,622
1957	838	1967	1,804
1958	1,715	1968	1,950
1959	1,891	1969	2,208
1960	1,834	1970	1,786
1961	2,092	1971	2,700

1/ Includes Cooper, Johnson, Lafayette, Pettis and Saline Counties.

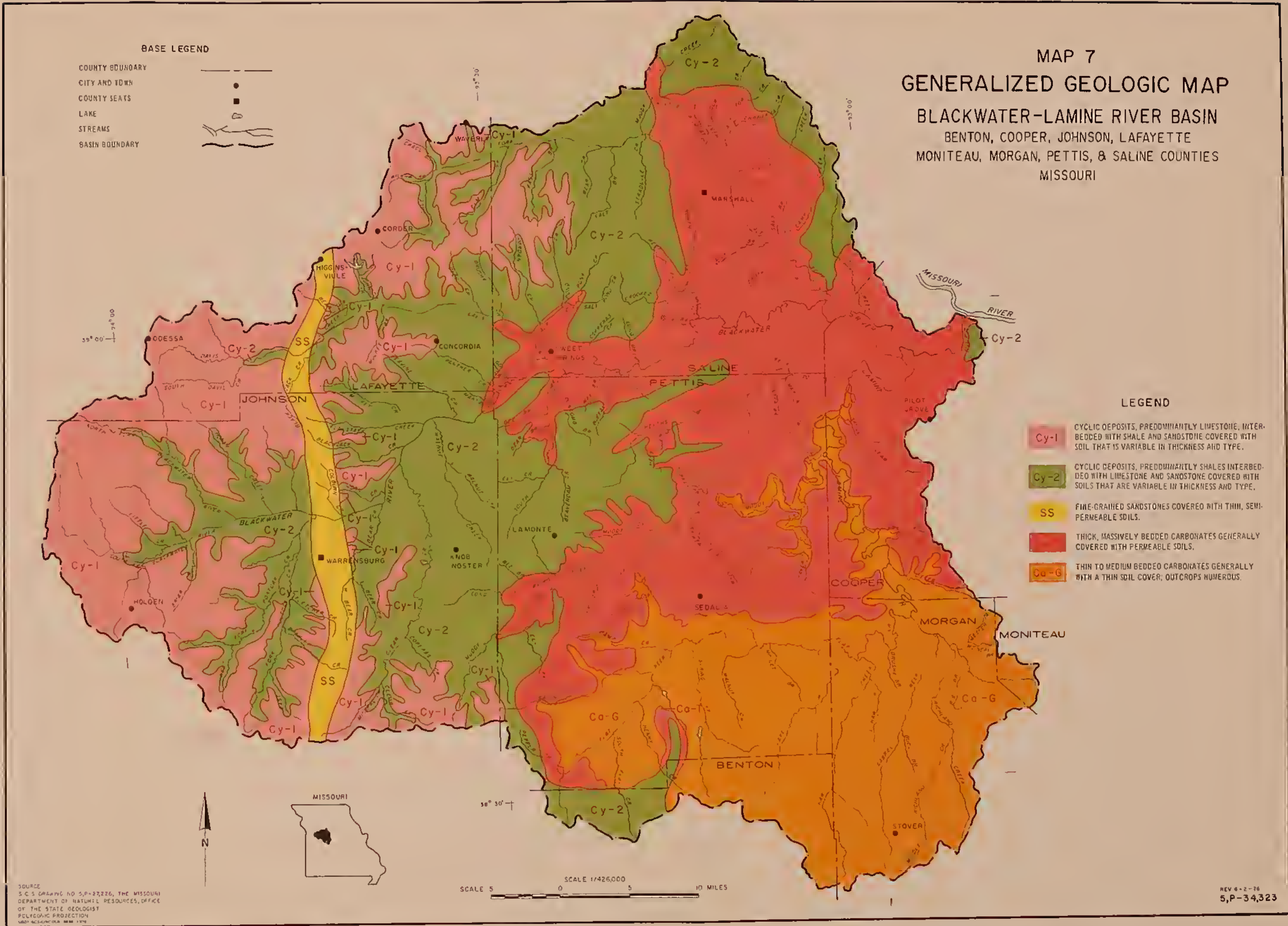

MAP 7
GENERALIZED GEOLOGIC MAP
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
BASIN BOUNDARY
LEGEND
Cy-1 CYCLIC DEPOSITS, PREDOMINANTLY LIMESTONE, INTERBEDDED WITH SHALE AND SANDSTONE COVERED WITH SOIL THAT IS VARIABLE IN THICKNESS AND TYPE.
Cy-2 CYCLIC DEPOSITS, PREDOMINANTLY SHALES INTERBEDDED WITH LIMESTONE AND SANDSTONE COVERED WITH SOILS THAT ARE VARIABLE IN THICKNESS AND TYPE.
SS FINE-GRAINED SANDSTONES COVERED WITH THIN, SEMI-PERMEABLE SOILS.
THICK, MASSIVELY BEDDED CARBONATES GENERALLY COVERED WITH PERMEABLE SOILS.
Ca-G THIN TO MEDIUM BEDDED CARBONATES GENERALLY WITH A THIN SOIL COVER; OUTCROPS NUMEROUS.
JOHNSON
LAFAYETTE
SALINE
PETTIS
COOPER
MORGAN
MONITEAU
BENTON
MISSOURI RIVER
BLACKWATER
WAVERLY
CORDER
HIGGINSVILLE
ODESSA
CONCORDIA
SWEET SPRINGS
MARSHALL
PILOT GROVE
LAMONTE
KNOB NOSTER
WARRENSBURG
HOLDEN
SEDALIA
STOVER
39° 00'
38° 30'
MISSOURI
N
SCALE 1/426,000
SCALE 5 0 5 10 MILES
SOURCE
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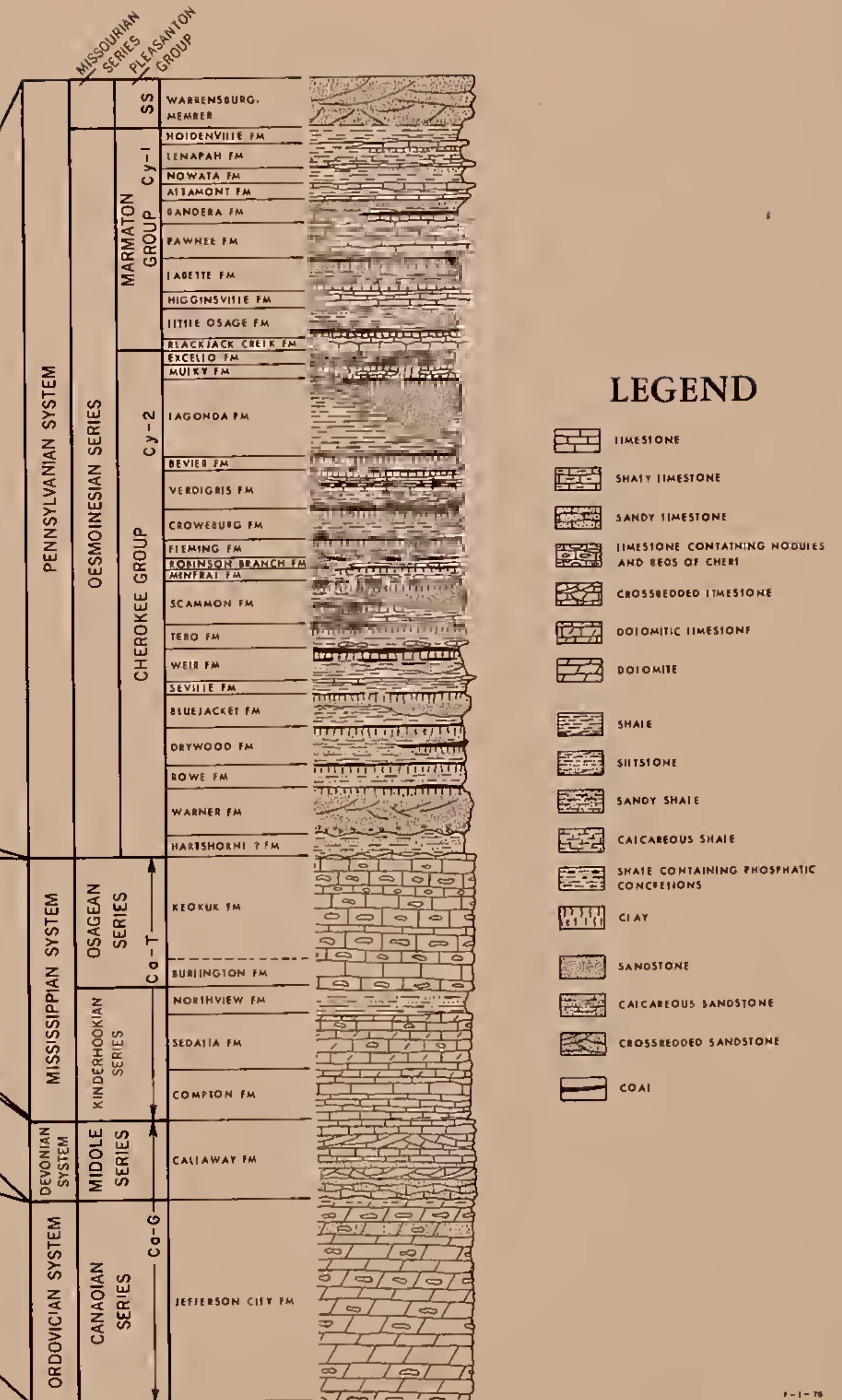
FIGURE 9

GEOLOGIC TIME SCALE OF MISSOURI ROCKS

MAJOR DIVISIONS		TYPE AND DISTRIBUTION OF ROCK
ERAS	PERIODS	
CENOZOIC	0 QUATERNARY 1,000,000 Q	Glacial deposits, loess, silt, sand, and gravel in modern streams and rivers.
	1 TERTIARY 63,000,000 T	Sand, gravel, clay, and shale; largely restricted to lowland region of southeastern Missouri.
MESOZOIC	64 CRETACEOUS 72,000,000 K	Clay and sand; restricted to southeastern Missouri as above.
	136 JURASSIC 46,000,000 J	No rocks of Jurassic age in state.
	182 TRIASSIC 49,000,000 ₮R	No rocks of Triassic age in state.
PALEOZOIC	231 PERMIAN 30,000,000 P	Sandstone; known from single locality in Atchison County.
	261 PENNSYLVANIAN 50,000,000 ℙ	Shale, limestone, sandstone, clay, and coal; present in more than two-thirds of the counties of the state; extensive in western and northern Missouri.
	311 MISSISSIPPIAN 35,000,000 M	Predominantly limestone, some shale; principal areas of outcrop are southwestern, central, east-central, and northeastern parts of the state.
	346 DEVONIAN 60,000,000 D	Predominantly limestone; exposed in central, eastern, and southeastern Missouri.
	406 SILURIAN 20,000,000 S	Predominantly limestone, exposed in northeastern and southeastern Missouri.
	426 ORDOVICIAN 75,000,000 O	Dolomite (magnesian limestone), limestone, sandstone, and shale; extensively exposed in Ozark area as far north as Montgomery County and west to McDonald and St. Clair counties, also exposed in parts of Ralls, Pike and Lincoln counties.
	501 CAMBRIAN 100,000,000 €	Dolomite, sandstone, and shale, major outcrops restricted to St. Francois Mountain area.
PRECAMBRIAN Includes several divisions of Era rank. Total time involved may have been as much as four billion years.	601	Igneous and metamorphic rocks; igneous exposed in St. Francois Mountain area.

SOURCE: MISSOURI DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGY AND LAND SURVEY



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The cumulative value for this period is nearly $40,000,000. The active mineral operations include 1 sandstone and 15 limestone quarries (Map 8).

(1) Stone

Stone is the major mineral resource in terms of production volume and value. Rock types quarried are limestone and sandstone. Limestone is produced for construction aggregates, agricultural limestone and riprap. Sandstone is quarried for dimension stone. In 1971 stone production for all uses amounted to 1.6 million tons valued at slightly over $2.5 million. Cumulative production from 1952 through 1971 was nearly 26 million tons valued at $33.1 million. Stone quality and quantity vary within the basin (Map 8). Six stone resource areas represent areas of similar rock type. Stone resources are sufficient to supply the basin and adjoining areas in the foreseeable future. However, these high-quality stone resources are not limitless and should be considered a stock resource to be conserved for use over time.

(2) Sand and Gravel

Sand and gravel resources are limited. Streams in Lafayette, Johnson, and Saline Counties are deficient in both sand and gravel, while streams in Cooper and Pettis Counties contain some gravel but only minor amounts of sand. Most sand for the region is produced by dredging operations on the Missouri River.

(3) Coal

Coal production in the basin was once of major importance (Table 12).

Table 12.--Coal Production and Resources, Blackwater-Lamine River Basin, Missouri

County	Past production 1000 tons	Total original resources -1000 tons- 1/	2/
Cooper	60	2,200	31,500
Johnson	2,760	1,240,000	3,052,850
Lafayette	26,603	559,900	829,150
Pettis	13	30,000	130,000
Saline	31	112,100	112,000
Total	29,467	1,944,200	4,155,500

1/ Searight 1966.
2/ Robertson 1970.

Production, principally from underground mines, ceased operations in 1964 in Lafayette County. Principal coal resources remaining are located in Johnson and Lafayette Counties (Map 9). The Lexington, Mulkey, and Wheeler are the more economical coal seams. The Lexington coal occurs at the top of the Labette Formation. The Mulkey coal is in the Mulkey formation and Wheeler coal in the Vertigris formation. These formations are in the Marmaton and Cherokee groups of the Desmoinesian Series of the Pennsylvanian Systems. While there is no indication that mining may resume, the basin contains a substantial and important coal reserve.

(4) Oil and Gas

Oil and gas production has not been reported from the basin, and commercial amounts are not expected to be found. Of possible greater significance is the presence of low-gravity, high-viscosity oil in north-central Lafayette County. These deposits are inferior in grade and have low economic importance with present recovery technology.

(5) Lead and Zinc

Lead and zinc have been found in northern Cooper County, but the size and low grade of these deposits give little promise of production. The possibility that deposits occur at greater depths does exist; however, deep exploratory drilling has not been encouraging.

(6) Magnetic Anomalies

Several magnetic anomalies are present within the basin. Anomalies similar to these may reflect the presence of iron ore (magnetite). A few exploratory holes have been drilled but results are not available.

(7) Barite

Minor deposits of barite have been mined within the region. Most of the mining was in northern Cooper County. Additional deposits probably exist in this area as well as in adjacent areas in Pettis, Morgan and Moniteau Counties. The ore is present in sink-like pockets. Because of their scattered distribution plus small size, the outlook for substantial future production is low.

(8) Clay and Shale

Clay and shale are abundant but have not been used extensively. Shales of the Cherokee and Marmaton Groups underlie the western one-half of the basin. Some units within these groups have been used for the manufacture of brick and other structural clay products. Recent studies indicate that many are suitable for the production of lightweight aggregate.

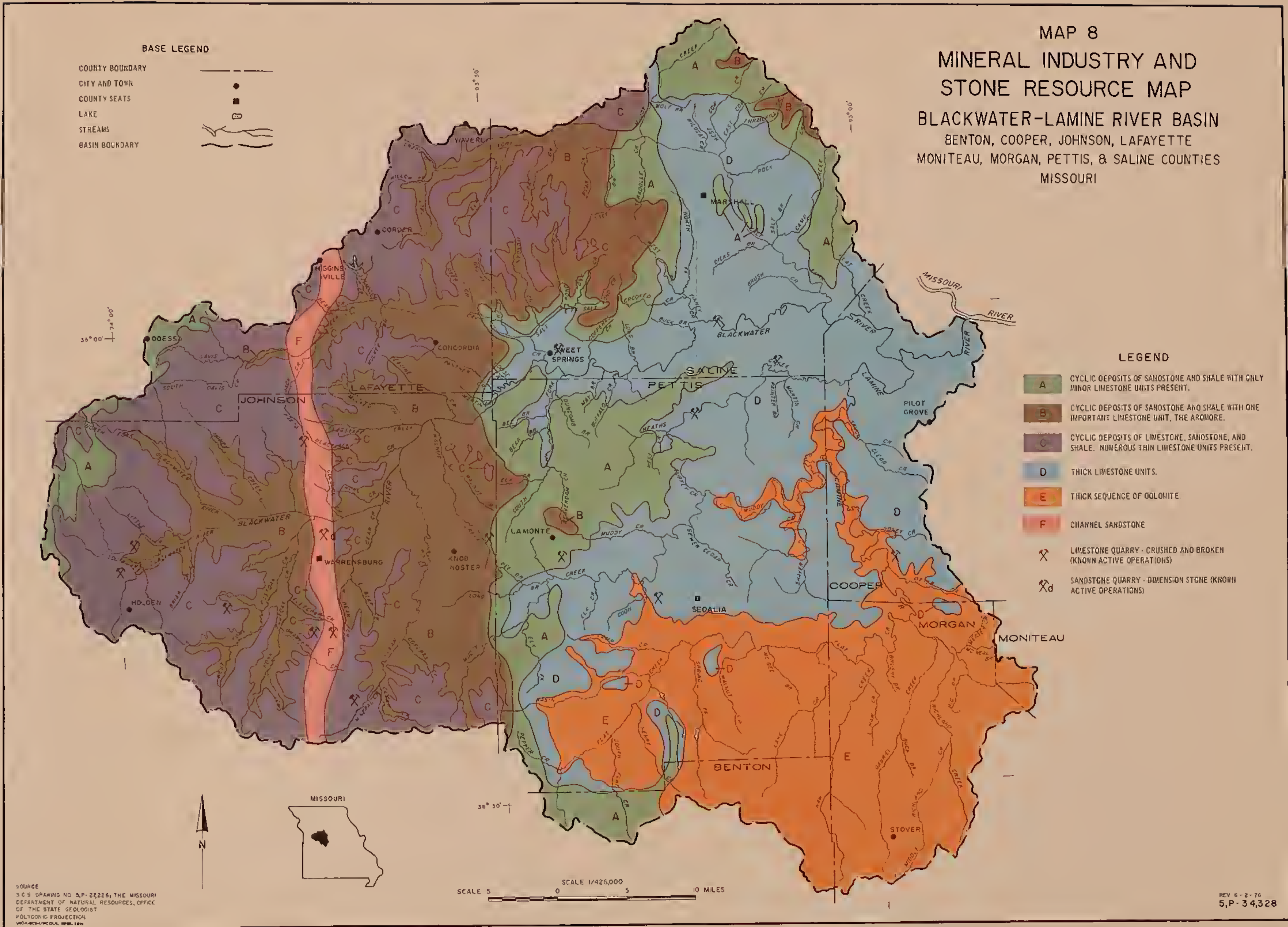
(9) Flint and Fire Clay

Flint and fire clay have been mined from minor deposits in Cooper and northern Morgan County. Although past production has been minor, the possibility of additional deposits exists in adjacent areas of Moniteau and Pettis Counties.

3. Soil Resources

Information on the soil resources are assembled and combined depending upon its intended use. Each grouping provides information that was used in the evaluation of the basin.

Soil associations, representing areas of similar soils, are combined into the broader land resource areas. Soils with similar problems and limitations are combined into land capability classes. And land capability



MAP 8
MINERAL INDUSTRY AND STONE RESOURCE MAP
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
BASIN BOUNDARY
LEGEND
A CYCLIC DEPOSITS OF SANDSTONE AND SHALE WITH ONLY MINOR LIMESTONE UNITS PRESENT.
B CYCLIC DEPOSITS OF SANDSTONE AND SHALE WITH ONE IMPORTANT LIMESTONE UNIT, THE ARDMORE.
C CYCLIC DEPOSITS OF LIMESTONE, SANDSTONE, AND SHALE. NUMEROUS THIN LIMESTONE UNITS PRESENT.
D THICK LIMESTONE UNITS.
E THICK SEQUENCE OF DOLOMITE.
F CHANNEL SANDSTONE
LIMESTONE QUARRY - CRUSHED AND BROKEN (KNOWN ACTIVE OPERATIONS)
SANDSTONE QUARRY - DIMENSION STONE (KNOWN ACTIVE OPERATIONS)
JOHNSON
LAFAYETTE
SALINE
PETTIS
COOPER
MORGAN
MONITEAU
BENTON
WAVERLY
CORDER
HIGGINSVILLE
CONCORDIA
ODESSA
SWEET SPRINGS
MARSHALL
BLACKWATER
PILOT GROVE
LAMONTE
KNOB NOSTER
WARRENSBURG
HOLDEN
SEDALIA
STOVER
MISSOURI RIVER
MISSOURI
N
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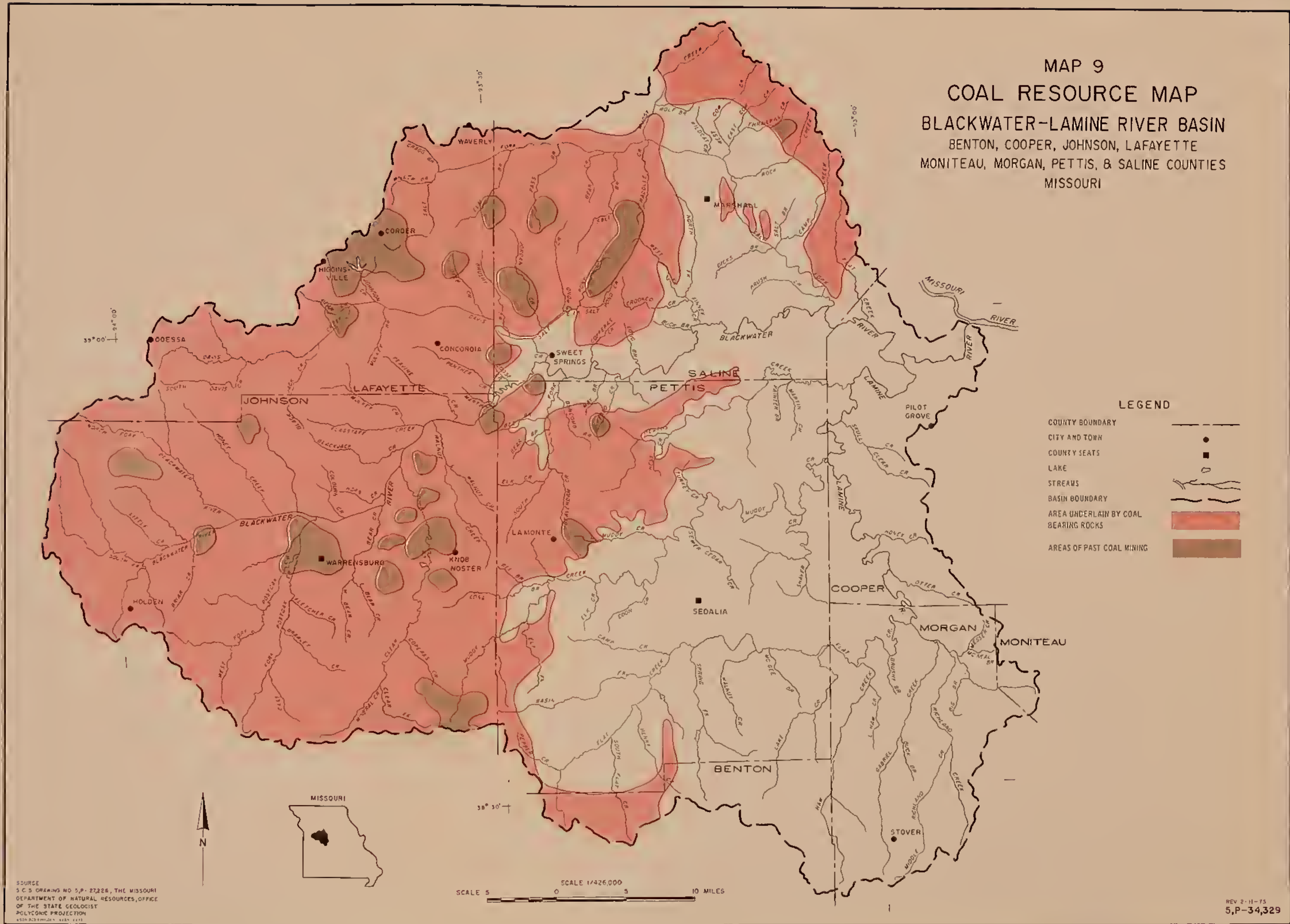
MAP 9
COAL RESOURCE MAP
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
BASIN BOUNDARY
AREA UNDERLAIN BY COAL BEARING ROCKS
AREAS OF PAST COAL MINING
WAVERLY
CORDER
HIGGINSVILLE
ODESSA
CONCORDIA
SWEET SPRINGS
MARSHALL
LAFAYETTE
JOHNSON
SALINE
PETTIS
COOPER
MORGAN
MONITEAU
BENTON
PILOT GROVE
LAMONTE
KNOB NOSTER
WARRENSBURG
HOLDEN
SEDALIA
STOVER
MISSOURI RIVER
BLACKWATER
LAMINE
39° 00'
38° 30'
N
MISSOURI
SCALE 1/426,000
SCALE 5 0 5 10 MILES
SOURCE
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classes having similar production capacities are combined into soil productivity groups. These are displayed in this section.

a. Major Land Resource Area

Three of the Major Land Resource Areas (LRA) are part of the Central Feed Grains and Livestock Land Resource Region. These areas include LRA 107-Iowa and Missouri Deep Loess Hills; LRA 112-Cherokee Prairies; and LRA 115-Central Mississippi Valley Wooded Slope (Map 9.1). LRA 116A-Ozark Border is part of the East and Central General Farming and Forested Land Resource Region.

Map 9.1.--Major Land Resource Areas, Blackwater-Lamine River Basin, Missouri

Much of LRA 107, a dissected loess-mantled glacial till plain, is rolling to hilly, but some of the broad uplands far from the large streams are level to undulating. The thickest deposits of loess are along the Missouri River bluffs, and the deposits become thinner with increasing distance from the bluffs. Water erodes these silty upland soils very easily. Most of the area is farmed. Corn, other feed grains, and hay are the principal crops.

Thin loess covers parts of LRA 112. The gently sloping to rolling dissected Cherokee Prairies are underlain by sandstone, shale, and limestone. The stream valleys are about 50 to 100 feet below the adjacent uplands. Most of the soils have dense clayey sub soils with slow and very slow permeability. They have wetness properties in the spring and are somewhat droughty in the summer. Nearly all of these areas are farmed. Corn,

soybeans, other feed grains, and hay are the main crops.

LRA 115 is primarily dissected hills having rolling narrow ridge tops and steep ridge slopes and valley sides. A thick loess mantle covers most of this area. The small streams have narrow valleys and steep gradients. Valley floors are one to several hundred feet below the adjoining hilltops.

These soils are easily eroded and some have fragipans. Most of the area is farmed. Feed grains and hay are the principal crops.

LRA 116A is a sharply dissected plateau with narrow rolling ridges that break to strongly rolling and steep side slopes. Valleys are narrow and have steep gradients. Local relief ranges from 50 to 100 feet in the upper reaches of the drainage ways to 200 to 300 feet in the valleys of the major streams.

Nearly three fourths of the area is in permanent vegetation due to the steep topography and shallow stony soils. Crops grown consist of corn, feed grains and hay.

b. Soil Association

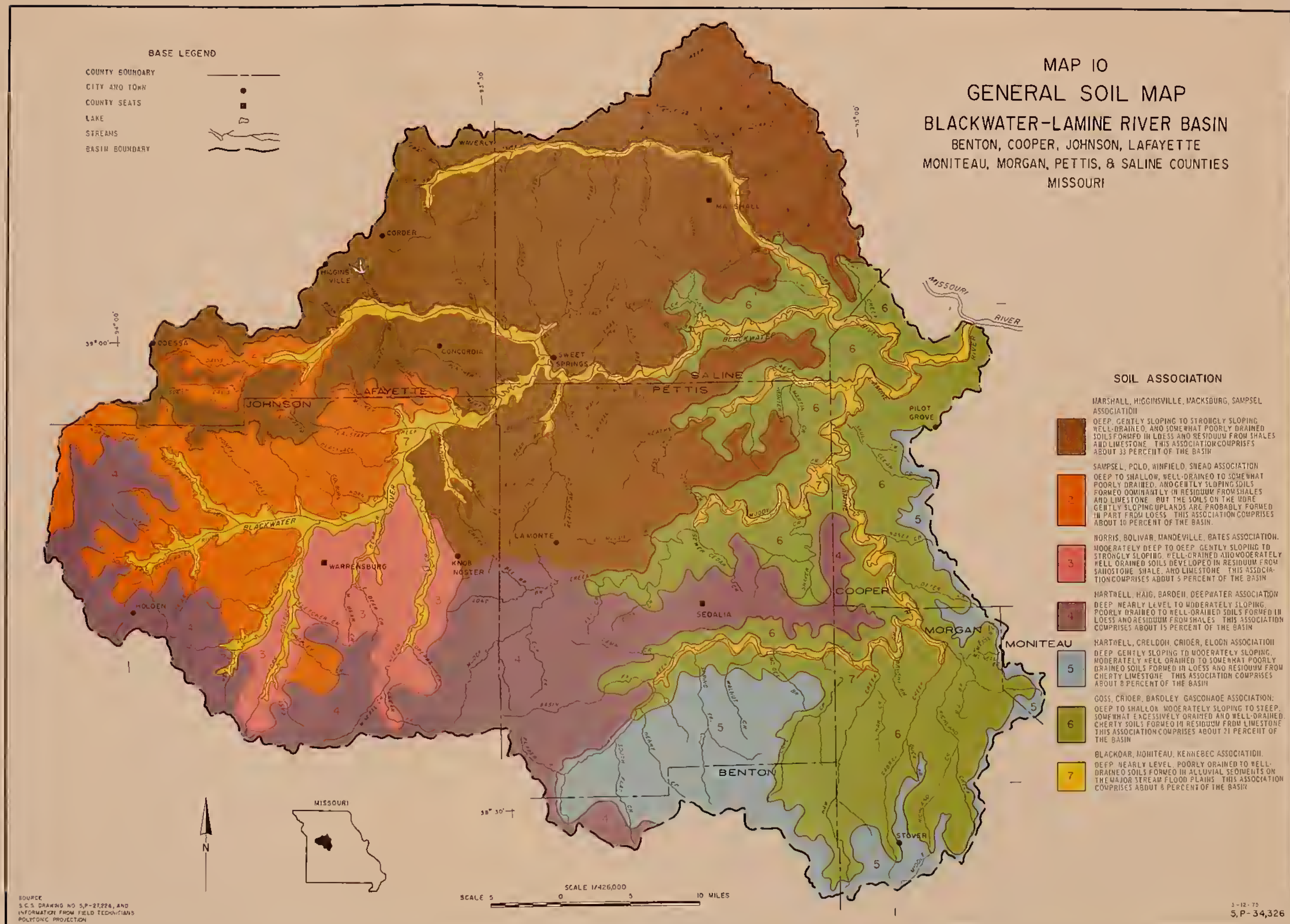
The general soil map is a display of soil associations which are landscapes with a distinctive soil pattern (Map 10). These associations consists of one or more major and at least two minor soils.

The soils in each association and the selected properties of each soil are displayed (Table 13). The limitation of these soils for several land uses are shown for community development, recreation and wildlife (Table 14 and 15).

The General Soil Map, properties and limitations provide a general guide for planning and managing a watershed, forest land or wildlife area. More detailed soil maps will be needed for specific locations when planning engineering works, recreational facilities and community developments begin.

c. Land Capability Classes

The land capability classification places all soils into eight capability classes (Figure 10). The grouping of soils is based primarily upon their capability to produce common cultivated crops and pasture plants without deterioration of the resource over a long period of time. The risks of soil damage or the limited use of soils become progressively greater from Class I to Class VIII. Soils in the first four classes, under good management, are capable of producing adapted plants such as trees or range plants and the common cultivated field crops and pasture plants. These classes comprise 88.9 percent of the Blackwater Subbasin and 80.2 percent of the Lamine Subbasin (Figure 11). Soils in Classes V, VI, and VII are suited to the use of adapted native plants. Some soils in Classes V and VI are also capable of producing specialized crops such as certain fruits and ornamentals and even field and vegetable crops under highly intensive management involving elaborate practices for soil and water conservation. Soils in Class VIII do not return on-site benefits for inputs of management for crops, grasses, or trees without major reclammation.



MAP 10
GENERAL SOIL MAP
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
BASIN BOUNDARY
SOIL ASSOCIATION
1 MARSHALL, HIGGINSVILLE, MACKSBURG, SAMPSEL ASSOCIATION
DEEP, GENTLY SLOPING TO STRONGLY SLOPING WELL-DRAINED, AND SOMEWHAT POORLY DRAINED SOILS FORMED IN LOESS AND RESIDUUM FROM SHALES AND LIMESTONE. THIS ASSOCIATION COMPRISES ABOUT 33 PERCENT OF THE BASIN
2 SAMPSEL, POLO, WINFIELD, SNEAD ASSOCIATION
DEEP TO SHALLOW, WELL-DRAINED TO SOMEWHAT POORLY DRAINED, AND GENTLY SLOPING SOILS FORMED DOMINANTLY IN RESIDUUM FROM SHALES AND LIMESTONE. BUT THE SOILS ON THE MORE GENTLY SLOPING UPLANDS ARE PROBABLY FORMED IN PART FROM LOESS. THIS ASSOCIATION COMPRISES ABOUT 10 PERCENT OF THE BASIN.
3 NORRIS, BOLIVAR, MANDEVILLE, BATES ASSOCIATION.
MODERATELY DEEP TO DEEP, GENTLY SLOPING TO STRONGLY SLOPING, WELL-DRAINED AND MODERATELY WELL DRAINED SOILS DEVELOPED IN RESIDUUM FROM SANDSTONE, SHALE, AND LIMESTONE. THIS ASSOCIATION COMPRISES ABOUT 5 PERCENT OF THE BASIN
4 HARTWELL, HAIG, BARDEN, DEEPWATER ASSOCIATION
DEEP, NEARLY LEVEL TO MODERATELY SLOPING, POORLY DRAINED TO WELL-DRAINED SOILS FORMED IN LOESS AND RESIDUUM FROM SHALES. THIS ASSOCIATION COMPRISES ABOUT 15 PERCENT OF THE BASIN
5 HARTWELL, CRELDON, CRIDER, ELDON ASSOCIATION
DEEP, GENTLY SLOPING TO MODERATELY SLOPING, MODERATELY WELL DRAINED TO SOMEWHAT POORLY DRAINED SOILS FORMED IN LOESS AND RESIDUUM FROM CHERTY LIMESTONE. THIS ASSOCIATION COMPRISES ABOUT 8 PERCENT OF THE BASIN
6 GOSS, CRIDER, BARDLEY, GASCONADE ASSOCIATION:
DEEP TO SHALLOW, MODERATELY SLOPING TO STEEP, SOMEWHAT EXCESSIVELY DRAINED AND WELL-DRAINED, CHERTY SOILS FORMED IN RESIDUUM FROM LIMESTONE. THIS ASSOCIATION COMPRISES ABOUT 21 PERCENT OF THE BASIN
7 BLACKOAR, MONITEAU, KENNEBEC ASSOCIATION.
DEEP, NEARLY LEVEL, POORLY DRAINED TO WELL-DRAINED SOILS FORMED IN ALLUVIAL SEDIMENTS ON THE MAJOR STREAM FLOOD PLAINS. THIS ASSOCIATION COMPRISES ABOUT 8 PERCENT OF THE BASIN
WAVERLY
MARSHALL
CORDER
HIGGINSVILLE
ODESSA
CONCORDIA
SWEET SPRINGS
SALINE
PETTIS
LAFAYETTE
JOHNSON
BLACKWATER
WARRENSBURG
KNOB NOSTER
LAMONTE
HOLDEN
SEDALIA
PILOT GROVE
COOPER
MORGAN
MONITEAU
BENTON
STOVER
MISSOURI RIVER
LAMINE RIVER
39° 00'
38° 30'
93° 30'
93° 00'
94° 00'
MISSOURI
N
SCALE 1/426,000
SCALE 5 0 5 10 MILES
SOURCE
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Table 13.--Selected Properties of Dominant Soils, Blackwater-Lamine River Basin, Missouri

Soil Associations	Area		Dominant Soils	Position on Landscape	Dominant Slope	Productivity Index 2/	Soil Drainage	Permeability	Available Water Capacity	Depth to Seasonal Water Table	Shrink-Swell Potential
	Percent	Acres	Percent 1/		Percent						
1	32.7	557,200									
Marshall			31	Upland	2-9	88	Well	Moderate	High	6	Moderate
Higginsville			21	Upland	5-14	90	Somewhat poorly	Slow	High	1-3	High
Macksburg			18	Upland	0-5	96	Somewhat poorly	Moderately slow	High	2-4	High
Sampsel			15	Upland	2-9	68	Somewhat poorly	Slow	Moderate	1-3	High
			(15)								
2	10.5	178,400									
Sampsel			29	Upland	2-9	68	Somewhat poorly	Slow	Moderate	1-3	High
Polo			22	Upland	4-9	80	Well	Moderate	Moderate	6	High
Winfield			16	Upland	2-30	76	Moderately well	Moderate	High	3-4	Moderate
Snead			15	Upland	4-20	46	Moderately well	Slow	Low	3-4	High
			(18)								
3	4.7	79,800									
Norris			23	Upland	5-50	16	Well	Moderate	Very low	6	Low
Bolivar			21	Upland	2-14	50	Well	Moderate	Low	6	Moderate
Mandeville			17	Upland	2-20	50	Moderately well	Moderate	Moderate	6	Low
Bates			16	Upland	1-8	68	Well	Moderate	Low	6	Moderate
			(23)								
4	15.5	265,000									
Hartwell			30	Upland	0-5	68	Poorly	Slow	Moderate	0.5-1.5	High
Haig			20	Upland	0-2	80	Poorly	Very slow	High	1-3	High
Barden			18	UPland	0-9	72	Moderately well	Slow	Moderate	2-3	High
Deepwater			15	Upland	1-10	84	Moderately well	Moderate	High	3-6	Moderate
			(17)								
5	8.0	136,000									
Hartwell			35	Upland	0-5	68	Poorly	Slow	Moderate	0.5-1.5	High
Creldon			26	Upland	2-9	52	Moderately well	Slow	Low	2-3	Moderate
Crider			14	Upland	0-20	62	Well	Moderate	High	6	Moderate
Eldon			10	Upland	2-25	34	Well	Moderate	Low	6	Moderate
			(15)								
6	20.8	353,600									
Goss			50	Upland	5-30	18	Well	Moderate	Low	6	Moderate
Crider			18	Upland	0-20	62	Well	Moderate	High	6	Moderate
Bardley			16	Upland	4-17	38	Well	Moderately slow	Low	6	High
Gasconade			10	Upland	2-50	9	Excessively	Moderately slow	Very low	6	Moderate
			(6)								
7	7.8	132,300									
Blackoar			45	Bottom land	0-2	84	Poorly	Moderate	Very high	1-3	Low
Moniteau			25	Terrace	0-2	62	Poorly	Slowly	High	1-2	Moderate
Kennebec			10	Bottom land	0-5	98	Moderately well	Moderate	Very high	2-5	Moderate
			(20)								

1/ Percent of Soil Association. Parenthesis () pertains to areas of minor soils.
2/ The statewide productivity index compares soil properties effecting crop production. The best possible combination gives a rating of 100.

Table 14.--Limitation of Soils for Recreation and Wildlife Uses, Blackwater-Lamine River Basin, Missouri

	RECREATION				WILDLIFE		
Dominant Soil in Associations	Camp Areas	Picnic Areas	Playgrounds	Paths and Trails	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
Marshall	Slight	Slight	Slight to moderate	Slight	Good	Good	Very poor A B
Higginsville	Moderate C D	Moderate C	Severe A	Moderate C	Good	Good	Very poor A
Macksburg	Moderate D	Moderate K	Moderate D	Moderate K	Good	Good	Fair D J
Sampsel	Moderate C D	Moderate C	Moderate C D	Moderate C	Fair A	Good	Very poor A
Sampsel	Moderate C D	Moderate C	Moderate C D	Moderate C	Fair A	Good	Very poor A
Polo	Slight	Slight	Moderate A	Slight	Good	Good	Very poor A B
Winfield	Slight to severe A	Slight to severe A	Moderate to severe A	Slight to severe A	Fair to good A	Good	Very poor A
Snead	Moderate to severe A	Moderate to severe A	Severe A	Moderate to severe A	Fair A F J	Fair A F K	Very poor A B
Norris	Slight to severe A	Slight to severe A	Severe A F	Slight to severe A	Poor A F G J	Very poor A F G J	Very poor A B F
Bolivar	Slight to moderate A	Slight to moderate A	Moderate to severe A	Slight	Good	Good	Very poor A B
Mandeville	Slight to severe A	Slight to severe A	Moderate to severe A	Slight to moderate A	Good to fair A	Good	Very poor A B
Bates	Slight	Slight	Moderate A F	Slight	Good	Fair F J	Very poor B D F
Hartwell	Severe C	Moderate C	Severe C	Moderate C	Good	Good	Fair to poor A
Haig	Severe C	Moderate C	Severe C	Moderate C	Good	Good	Fair to poor A
Barden	Moderate C D	Slight	Moderate C D	Slight	Good	Good	Poor A
Deepwater	Slight	Slight	Slight to moderate A	Slight	Good	Good	Very poor A B
Hartwell	Severe C	Moderate C	Severe C	Moderate C	Good	Good	Fair to poor A
Creldon	Moderate C	Slight	Moderate A C	Slight	Fair A D J	Fair A D J	Very poor A B
Crider	Slight to severe A	Slight to severe A	Slight to severe A	Slight to moderate A	Fair A	Fair A	Very poor A B
Eldon	Slight to severe A	Slight to severe A	Moderate to severe A	Slight to moderate A	Fair A G J	Fair A G J	Very poor A B G
Goss	Moderate to severe A	Moderate to severe A	Severe A G	Moderate G	Fair A G J	Fair A G J	Very poor A B
Crider	Slight to severe A	Slight to severe A	Slight to severe A	Slight to moderate A	Fair A	Fair A	Very poor A B
Bardley	Moderate A D	Slight to moderate A	Severe A	Slight to moderate A	Poor A F J	Poor A F J	Very poor A B
Gasconade	Severe G	Severe G	Severe F G	Severe G	Poor A F G J	Poor A F G J	Very poor A B F
Blackoar	Severe C E	Moderate C E	Moderate C E	Moderate C E	Good	Fair C E	Fair D
Moniteau	Severe C E	Severe C	Severe C	Severe C	Fair C E	Fair C E	Fair D
Kennebec	Severe E	Moderate E	Moderate E	Slight	Good	Good	Poor D K

A Slope
B No water table
C Seasonal water table
D Permeability
E Flooding
F Depth to rock
G Coarse fragments
H Shrink - Swell potential
I Frost action
J Available water capacity
K Soil texture

Table 15.--Limitation of Soil for Community Development, Blackwater-Lamine River Basin, Missouri

Dominant Soil in Associations	COMMUNITY DEVELOPMENT Septic Fields	Sewage Lagoons	Dwellings with Basements	Dwellings without Basements	Local Roads and Streets
Marshall	Slight to moderate A	Moderate D	Slight	Slight	Moderate H
Higginsville	Severe D	Moderate A	Severe C H	Severe H	Moderate C H
Macksburg	Severe C D	Slight to moderate A	Severe C H	Severe H	Severe H I
Sampsel	Severe C D	Moderate A	Severe C H	Severe H I	Severe H I
Sampsel	Severe C D	Moderate A	Severe C H	Severe H I	Severe H I
Polo	Slight	Severe A D	Severe H	Moderate H	Moderate H
Winfield	Severe C	Moderate to severe A	Moderate to severe A C H	Moderate to severe A H	Moderate to severe A H
Snead	Severe D F	Severe A F	Severe H	Severe H	Severe H
Norris	Severe A F	Severe A F	Moderate to severe A F	Moderate to severe A F	Moderate to severe A F
Bolivar	Severe F	Severe F	Moderate F H	Moderate H	Moderate H
Mandeville	Severe F	Severe F K	Moderate to severe A F	Moderate to severe A I	Moderate to severe A I
Bates	Severe F	Severe F	Severe F	Moderate F H	Moderate F
Hartwell	Severe C D	Slight to moderate A	Severe C H	Severe C H	Severe H
Haig	Severe C D	Moderate A D K	Severe C H	Severe C H	Severe C H
Barden	Severe C D	Slight to moderate A	Severe C H	Severe H	Severe H
Deepwater	Moderate C D	Moderate to severe A C D	Moderate C H	Moderate H	Moderate H
Hartwell	Severe C D	Slight to moderate A	Severe C H	Severe C H	Severe H
Creldon	Severe C D	Moderate A D K	Moderate C H	Moderate C H	Moderate C H
Crider	Moderate to severe A D	Moderate to severe A D	Slight to severe A	Slight to severe A	Slight to severe A
Eldon	Moderate to severe A D	Severe D G	Moderate to severe A H	Moderate to severe A H	Moderate to severe A H
Goss	Moderate to severe A	Severe A D	Moderate to severe A	Moderate to severe A	Moderate to severe A
Crider	Moderate to severe A D	Moderate to severe A D	Slight to severe A	Slight to severe A	Slight to severe A
Bardley	Severe A D	Severe A F	Severe A F	Moderate to severe A F	Moderate to severe A F
Gasconade	Severe F G	Severe D F	Severe F G	Severe F G	Severe F G
Blackoar	Severe C E	Severe C E	Severe C E	Severe C E	Severe C E
Moniteau	Severe C D E	Severe C E	Severe C E	Severe C E	Severe C E I
Kennebec	Severe C E	Severe C E	Severe C E	Severe E	Severe E

A Slope
B No water table
C Seasonal water table
D Permeability
E Flooding
F Depth to rock
G Coarse fragments
H Shrink - Swell potential
I Frost action
J Available water capacity
K Soil texture

Figure 10.--Land Capability Classification, Blackwater-Lamine River Basin, Missouri

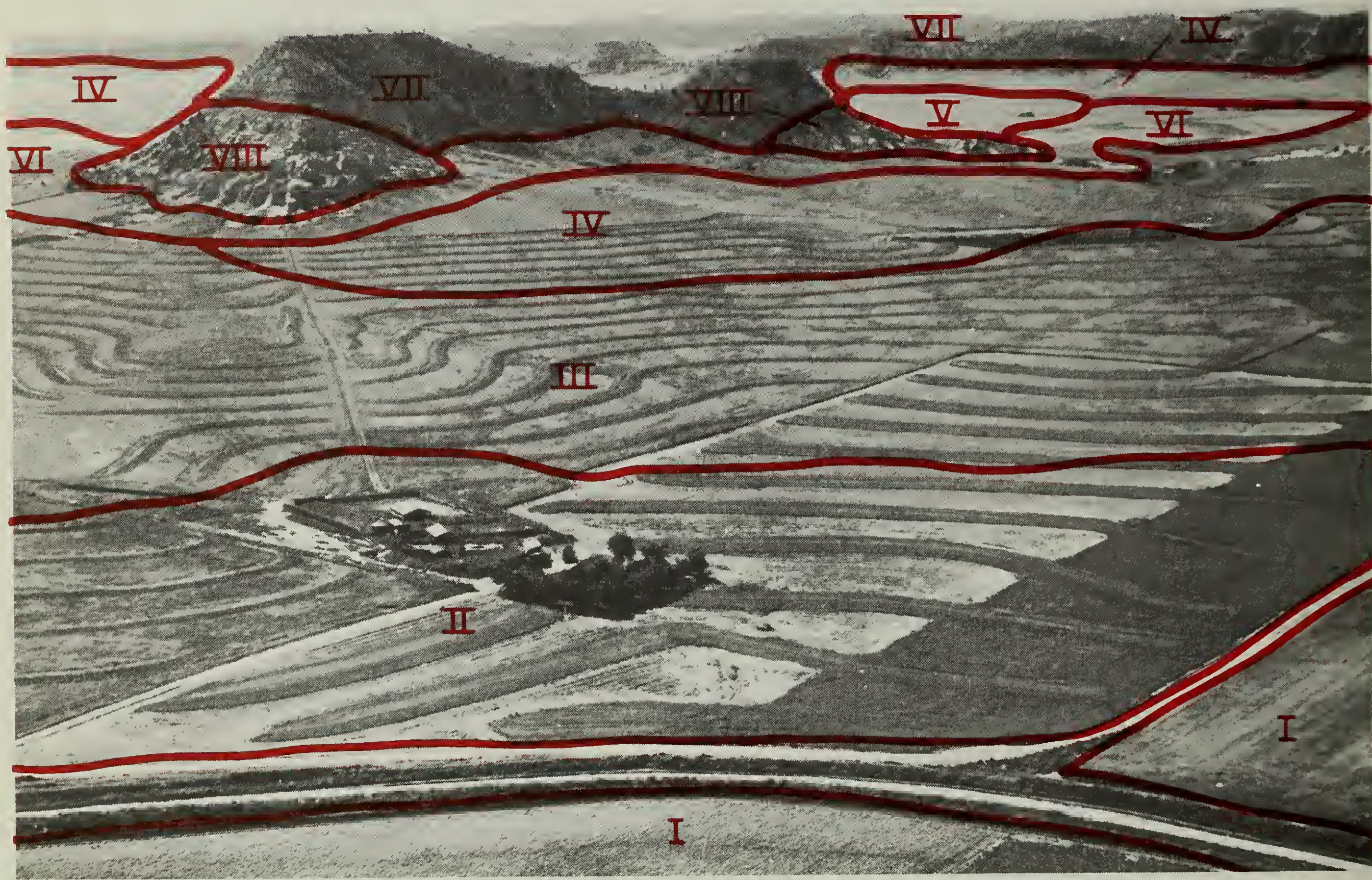
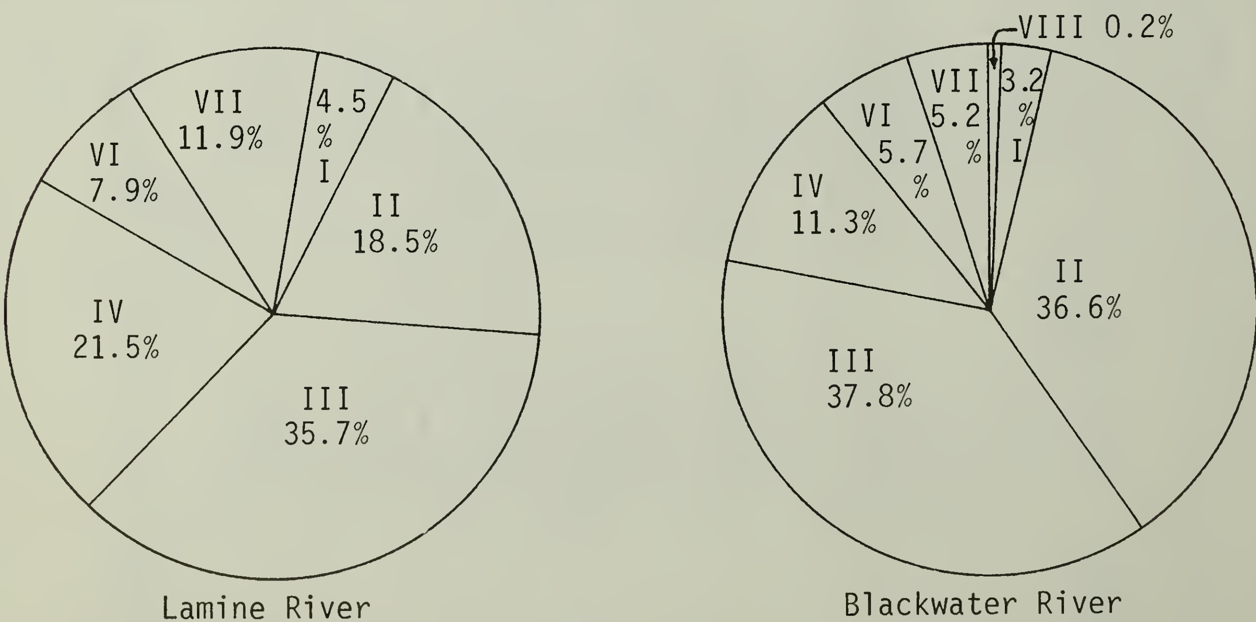
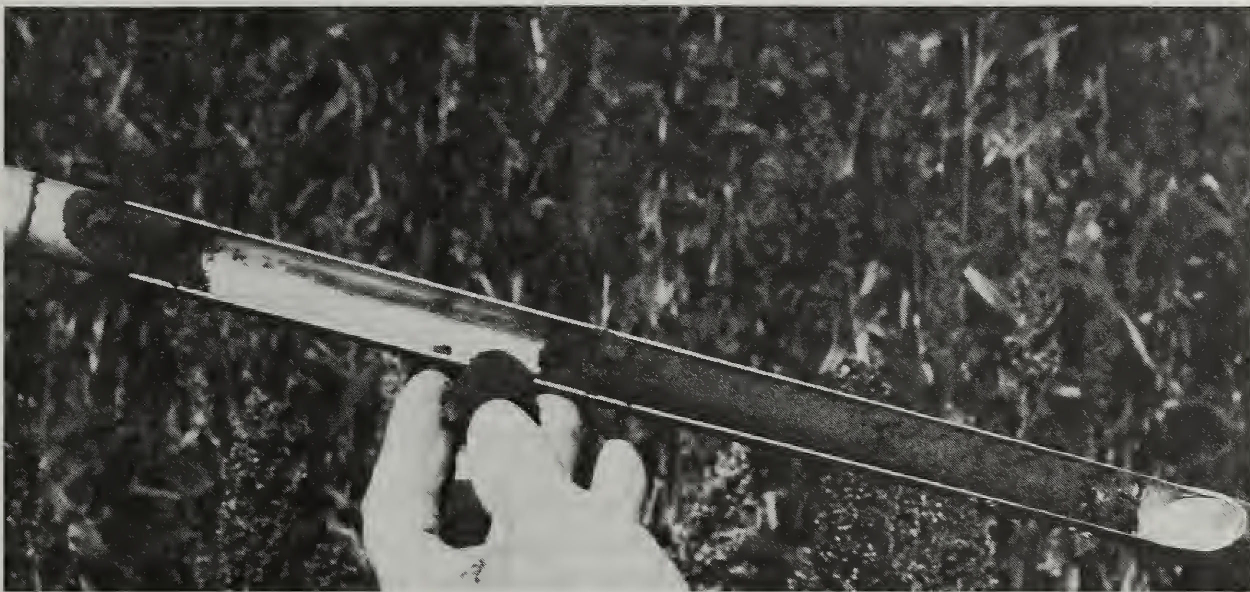


Figure 11.--Distribution by Land Capability Classes, Blackwater-Lamine River Basin, Missouri





Our soils are an important natural resource needed for current and future production.

The eight capability classes described below are further divided into sub-classes that show the principal kinds of problems involved. The sub-classes are: erosion, wetness, soil limitations (shallowness or droughtiness), and climatic limitations.

Class I - Soils in this class are suited to a wide range of plants and may be used safely for cultivated crops, pasture, range, woodland, and wildlife. The soils are nearly level and erosion hazard (wind or water) is low. They are deep, generally well drained, and easily worked. They hold water well and are either fairly well supplied with plant nutrients or highly responsive to inputs of fertilizer. These soils are not subject to damaging overflow. They are productive and suited to intensive cropping. The local climate must be favorable for growing many of the common field crops.

Class II - Soils in this class require careful soil management, including conservation practices, to prevent deterioration or to improve air and water relations when the soils are cultivated. The limitations are few and the practices are easy to apply. The soils may be used for cultivated crops, pasture, range, woodland, or wildlife food and cover.

Limitations of these soils may include singly or in combination the effects of (1) gentle slopes, (2) moderate susceptibility to wind or water erosion or moderate adverse effects of past erosion, (3) less than ideal soil depth, (4) somewhat unfavorable soil structure and workability, (5) slight to moderate salinity or sodium easily corrected but likely to recur, (6) occasional damaging overflow, (7) wetness correctable by drainage but existing permanently as a moderate limitation, and (8) slight climatic limitations on soil use and management.

Class III - Soils in this class have more restrictions than those in Class II and when used for cultivated crops the conservation practices are usually more difficult to apply and to maintain. They may be used for cultivated crops, pasture, woodland, range, or wildlife food and cover.

Limitations of soils restrict the amount of clean cultivation; timing of planting, tillage, and harvesting; choice of crops; or some combination of these limitations. The limitations may result from the effects of one or more of the following: (1) Moderately steep slopes; (2) high susceptibility to water or wind erosion or severe adverse effects of past erosion; (3) frequent overflow accompanied by some crop damage; (4) very slow permeability of the subsoil; (5) wetness or some continuing waterlogging after drainage; (6) shallow depths to bedrock, hardpan, fragipan, or claypan that limit the rooting zone and the water storage; (7) low moisture-holding capacity; (8) low fertility not easily corrected; (9) moderate salinity or sodium; or (10) moderate climatic limitations.

Class IV - The restrictions in use for soils in this class are greater than those in Class III and the choice of plants is more limited. When these soils are cultivated, more careful management is required and conservation practices are more difficult to apply and maintain. Soils may be used for crops, pasture, woodland, range, or wildlife food and cover.

These soils may be well suited to only two or three of the common crops or the harvest produced may be low in relation to inputs over a long period of time. Use for cultivated crops is limited as a result of the effects of one or more permanent features such as (1) steep slopes, (2) severe susceptibility or water or wind erosion, (3) severe effects of past erosion, (4) shallow soils, (5) low moisture-holding capacity, (6) frequent overflows accompanied by severe crop damage, (7) excessive wetness with continuing hazard of waterlogging after drainage, (8) severe salinity or sodium, or (9) moderately adverse climate.

Land limited in use and generally not suited to cultivation, Class V through VIII are 11.1 percent for the Blackwater Subbasin and 19.8 percent for the Lamine Subbasin.

Class V - Soils in this class have limitations that restrict the kind of plants that can be grown and that prevent normal tillage of cultivated crops. They are nearly level but some are wet, are frequently overflowed by streams, are stony, have climatic limitations, or have some combination of these limitations. Examples of Class V are (1) soils of the bottom lands subject to frequent overflow that prevents the normal production of cultivated crops, (2) nearly level soils with a growing season that prevents the normal production of cultivated crops, (3) level or nearly level stony or rocky soils, and (4) ponded areas where drainage for cultivated crops is not feasible but where soils are suitable for grasses or trees. Because of these limitations cultivation of the common crops is not feasible but pastures can be improved and benefits from proper management can be expected.

Class VI - Physical conditions of soils placed in Class VI are such that it is practical to apply range or pasture improvements, if needed, such as seeding, liming fertilizing, and water control with contour furrows, drainage ditches, diversions, or water spreaders. Soils in Class VI have continuing limitations that cannot be corrected, such as (1) steep slope, (2) severe erosion hazard, (3) effects of past erosion, (4) stoniness, (5) shallow rooting zone, (6) excessive wetness or overflow, (7) low-moisture capacity, (8) salinity or sodium, or (9) severe climate. Because of one or more of these limitations these soils are not generally suited to cultivated crops. But they may be used for pasture, range, woodland, or wildlife cover or for some combination of these.

Class VII - Physical conditions of soils in Class VII are such that it is impractical to apply such pasture or range improvements as seeding, liming, fertilizing, or water control with contour furrows, ditches, diversions, or water spreaders. Soil restrictions are more severe than those in Class VI because of one or more continuing limitations that cannot be corrected, such as (1) very steep slopes, (2) erosion, (3) shallow soil, (4) stones, (5) wet soil, (6) salts or sodium, (7) unfavorable climate, or (8) other limitations that make them unsuited to common cultivated crops. They can be used safely for grazing or woodland or wildlife food and cover or for some combination of these under proper management.

Class VIII - Soils and landforms in Class VIII cannot be expected to return significant on-site benefits from management for crops, grasses,

or trees, although benefits from wildlife use, watershed protection, or recreation may be possible.

Limitations that cannot be corrected may result from the effects of one or more of the following: (1) Erosion or erosion hazard, (2) severe climate, (3) wet soil, (4) stones, (5) low-moisture capacity, and (6) salinity or sodium.

Badlands, rock outcrop, sandy beaches, river wash, mine tailings, and other nearly barren lands are included in Class VIII. It may be necessary to give protection and management for plant growth to soils and landforms in Class VIII in order to protect other more valuable soils, to control water, or for wildlife or aesthetic reasons.

d. Soil Productivity Groups

The soil productivity groups (SPG) are a combination of capability units with similar agricultural productivity and costs of production (Table 16). Potential agricultural production, costs of production, net income, and soil erosion for present and future conditions were analyzed for each SPG.

Three bottom land SPG's are designated as B_1, B_2, and B_3 and three upland SPG's are designated as U_1, U_2, and U_3 (Table 17). The alluvial soils account for about 16 percent of the area in both subbasins and the upland soils account for 84 percent. The highest producing upland SPG, U_1, is more prominent in the Blackwater Subbasin. The dominant SPG, U_2, accounts for nearly half of the total basin area while the lowest producing SPG, U_3, comprises 12 percent of the basin.

4. Land and Land Use

A discussion of presettlement vegetation is included as part of the setting for land use. It pictures changes that have occurred since European settlement. Capability classes and the broader major land resource areas define the capability of the land to sustain production and the limits of the land for intensive use. The present and projected land use is presented.

a. Presettlement Vegetation

Early vegetation was influenced by three general land features, the Ozark Border, Cherokee Prairie and Deep Loess Prairie. The northwestern part of Ozark Border area influenced the eastern part of the basin. The unglaciated Cherokee Prairie area was a dominant influence--wedging into the basin from the southwest. A Deep Loess Prairie on glacial till area dominated the northern half of the basin (Map 11). An examination of the plant associations will help explain the vegetative relationships. Approximately 60 percent of the native vegetation was grasslands, 30 percent forest, and 10 percent bottom land in forest and wet meadows (Table 18).

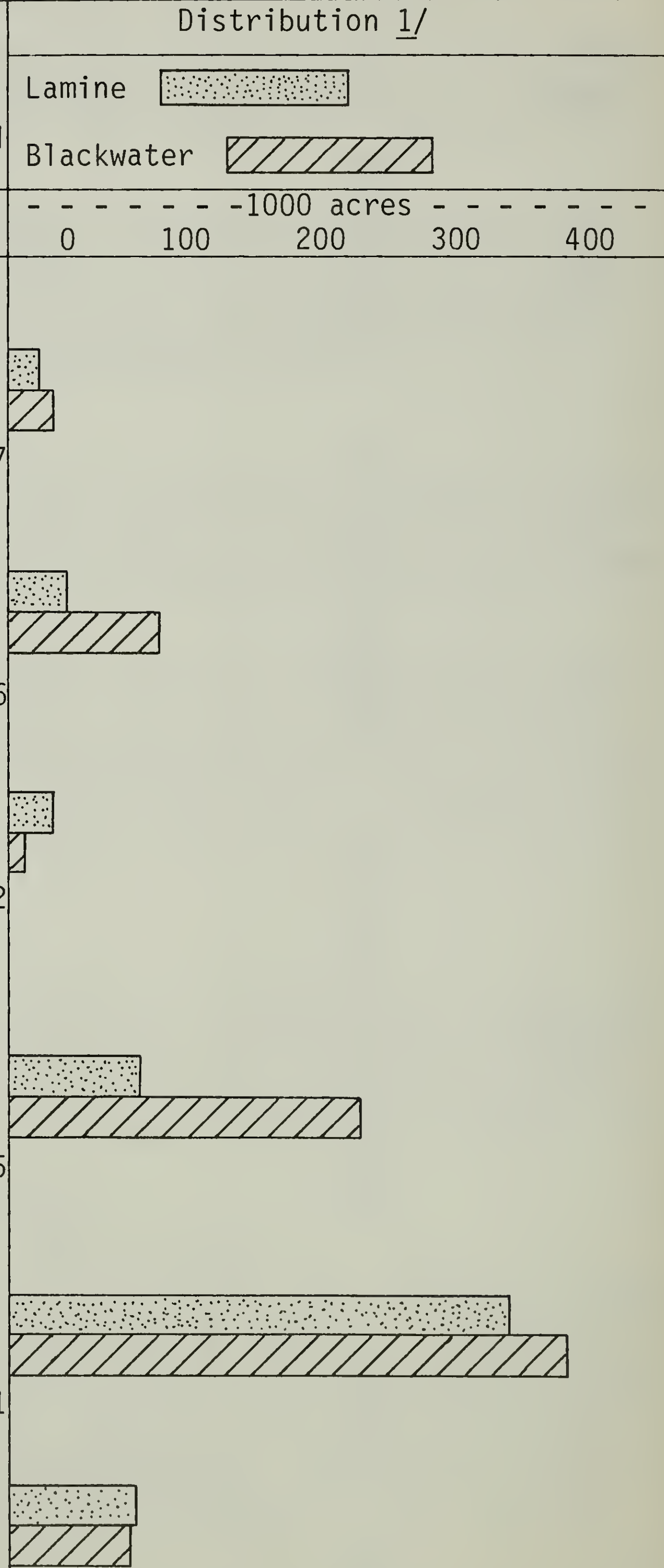
Loamy upland prairies exemplify the greatest possible tall grass development. These prairies made up about 20 percent of the area. Approximately 52 percent of the Marshall-Higginsville-Macksburg-Sampsel Soil Association was loamy upland prairie. Also, this prairie made up 28 percent of the vegetation in the Sampsel-Polo-Winfield-Snead and the Norris-Bolivar-Mandeville-

Table 16.--Percentage Distribution of Soil Capability Classes by Soil Productivity Groups, Blackwater-Lamine River Basin, Missouri

Soil Group	Soil Class	Subbasin		Total Basin
		Lamine	Blackwater	
		percent		
U_1	2E01	.7	5.3	3.3
	2E02	.6	---	.3
	2E06	5.0	20.2	13.4
	3E01	2.9	2.5	2.7
	3E02	4.9	.2	2.2
	3E03	1.3	---	.6
		15.4	28.2	22.5
U_2	2S01	.9	---	.4
	3S01	.5	---	.2
	3E05	24.2	4.0	12.6
	3E06	13.5	29.3	22.7
	4E01	1.3	---	.6
	4E02	5.3	1.8	3.3
	4E03	3.1	.4	1.4
	4E05	2.3	4.0	3.3
	4E06	3.8	5.0	4.5
	4S04	---	.1	.1
		54.9	44.6	49.1
U_3	6E02	2.1	.8	1.3
	6E03	2.2	1.2	1.6
	6E05	.3	.9	.6
	6E06	.5	1.0	.8
	6S04	---	.3	.2
	6S06	.4	.8	.6
	7E03	1.0	2.2	1.8
	7E05	---	.2	.1
	7E06	---	---	---
	7S04	---	---	---
	7S06	7.6	2.7	4.8
	8S04	---	.2	.1
		14.1	10.3	11.9
B_1	I	3.6	3.7	3.7
B_2	2W01	6.2	11.0	9.2
	2W03	.1	.3	.3
	6W01	---	.1	.1
		6.3	11.8	9.6
B_3	3W01	.7	---	.3
	3W02	4.4	.3	2.0
	3W04	.6	1.1	.9
		5.7	1.4	3.2
Total		100.0	100.0	100.0

Table 17.--Soil Productivity Groups, Blackwater-Lamine River Basin, Missouri

Soil Productivity Group Description	Total area Percent
Bottom land soils	
B-1 Deep medium textured, moderately to slowly permeable, level to gently sloping. The flood-free soils in this group are the highest yielding soils in the basin.	3.7
B-2 Poorly drained, medium textures, slowly permeable. Level. Includes seasonably wet areas caused by seepage. Crop yields are lower than group B-1 because of soil wetness.	9.6
B-3 Deep planosols with fine textured subsoils, very slowly permeable. Nearly level. Crop yields slightly lower than group B-2 because of soil texture.	3.2
Upland Soils	
U-1 Deep, well to somewhat poorly drained. Medium to fine textured. Moderately to slowly permeable soils with firm subsoils. Highest yielding of upland soils.	22.5
U-2 Same as group U-1 except sloping up to moderately steep (14 percent slope) including eroded phase. Lower yields than group U-1 because of more erosion.	49.1
U-3 Deep to shallow mostly stony soils with rock outcrops on variable slopes. Lowest yielding soil group because of steepness, soil texture and soil fertility.	11.9
	100.0



1/ Inventory Land Only

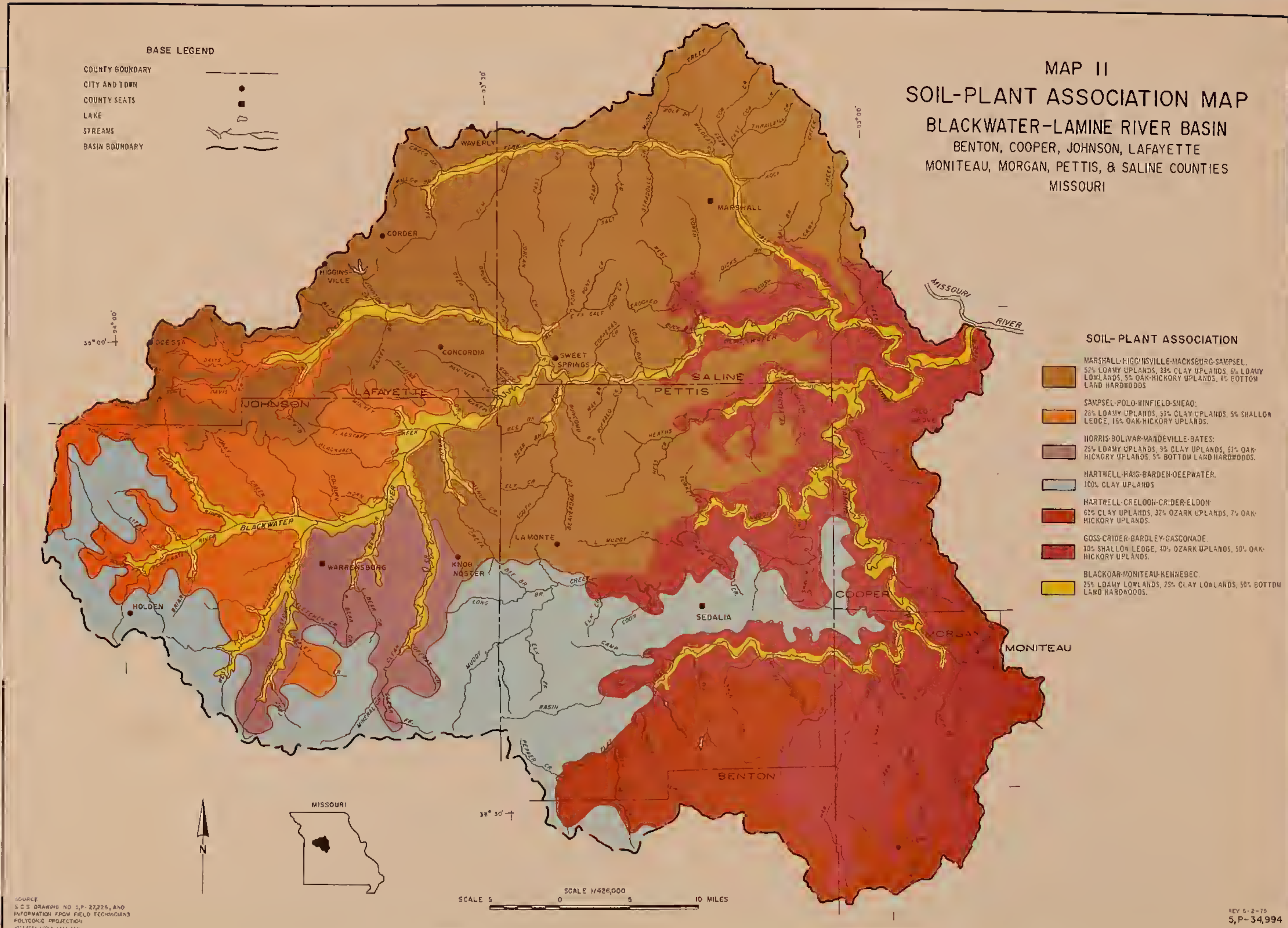

MAP II
SOIL-PLANT ASSOCIATION MAP
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
BASIN BOUNDARY
SOIL-PLANT ASSOCIATION
MARSHALL-HIGGINSVILLE-MACKSBURG-SAMPSEL.
52% LOAMY UPLANDS, 33% CLAY UPLANDS, 6% LOAMY LOWLANDS, 5% OAK-HICKORY UPLANDS, 4% BOTTOM LAND HARDWOODS
SAMPSEL-POLO-WINFIELD-SNEAD:
28% LOAMY UPLANDS, 51% CLAY UPLANDS, 5% SHALLOW LEDGE, 16% OAK-HICKORY UPLANDS.
NORRIS-BOLIVAR-MANDEVILLE-BATES:
25% LOAMY UPLANDS, 9% CLAY UPLANDS, 61% OAK-HICKORY UPLANDS, 5% BOTTOM LAND HARDWOODS.
HARTWELL-HAIG-BARDEN-DEEPWATER.
100% CLAY UPLANDS
HARTWELL-CRELDON-CRIDER-ELDON
61% CLAY UPLANDS, 32% OZARK UPLANDS, 7% OAK-HICKORY UPLANDS.
GOSS-CRIDER-BARDLEY-GASCONADE.
10% SHALLOW LEDGE, 40% OZARK UPLANDS, 50% OAK-HICKORY UPLANDS.
BLACKOAR-MONITEAU-KENNEBEC.
25% LOAMY LOWLANDS, 25% CLAY LOWLANDS, 50% BOTTOM LAND HARDWOODS.
MISSOURI RIVER
WAVERLY
MARSHALL
CORDER
HIGGINSVILLE
CONCORDIA
SWEET SPRINGS
ODESSA
LAFAYETTE
SALINE
JOHNSON
PETTIS
BLACKWATER RIVER
WARRENSBURG
KNOB NOSTER
LA MONTE
HOLDEN
SEDALIA
COOPER
MORGAN
MONITEAU
BENTON
39° 00'
38° 30'
93° 30'
93° 00'
94° 00'
N
MISSOURI
SCALE 1/426,000
SCALE 5 0 5 10 MILES
SOURCE
S.C.S. DRAWING NO. 5,P-27,226, AND
INFORMATION FROM FIELD TECHNICIANS
POLYCONIC PROJECTION
REV. 6-2-75
5,P-34,994

Table 18.--Presettlement Plant Association, Blackwater-Lamine River Basin, Missouri

Soil Associations	Plant Association Sites								Total (Acres)
	Grasslands				Savannah-like		Forestlands		
	Loamy Uplands	Clay Uplands	Loamy Lowlands	Clay Lowlands	Shallow Ledge	Ozark Uplands	Oak-Hickory Uplands	Bottom-land Hard-woods	
	Acres / Percent	Acres / Percent	Acres / Percent	Acres / Percent	Acres / Percent	Acres / Percent	Acres / Percent	Acres / Percent	
Marshall-Higginsville-Macksburg-Sampsel	289,744 / 52	183,876 / 33	33,432 / 6	- - - -	- - - -	- - - -	27,860 / 5	22,288 / 4	557,200
Sampsel-Polo-Winfield-Snead	49,952 / 28	90,984 / 51	- - - -	- - - -	8,920 / 5	- - - -	28,544 / 16	- - - -	178,400
Norris-Bolivar-Mandeville-Bates	19,950 / 25	7,182 / 9	- - - -	- - - -	- - - -	- - - -	48,678 / 61	3,990 / 5	79,800
Hartwell-Haig-Barden-Deepwater	- - - -	265,000 / 100	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	265,000
Hartwell-Creldon-Crider-Eldon	- - - -	82,960 / 61	- - - -	- - - -	- - - -	43,520 / 32	9,520 / 7	- - - -	136,000
Goss-Crider-Bardley-Gasconade	- - - -	- - - -	- - - -	- - - -	35,360 / 10	141,440 / 40	176,800 / 50	- - - -	353,600
Blackoar-Moniteau-Kennebec	- - - -	- - - -	33,075 / 25	33,075 / 25	- - - -	- - - -	- - - -	66,150 / 50	132,300
SUMMARY	359,500 / 21	630,000 / 37	66,500 / 4	33,000 / 2	44,500 / 3	185,000 / 11	291,400 / 17	92,400 / 5	1,702,300

Bates Soil Association.

Upland claypan prairies were found on about 37 percent of the basin. The heavy subsoil features of a claypan soil amplify the recurring moisture conditions. During periods of high moisture these soils, having slow internal drainage, stay saturated for long periods. During drought periods, the high clay content limits available water for plant growth. Lower average yields of vegetative matter were characteristic of the clay prairie. Drought tolerant species were dominant during below normal rainfall. The claypan sites discouraged the establishment of woody species more than the loamy sites. The other forces working to maintain grassland were not as strong on the claypan as the loamy sites.

Bottom lands were covered with wet meadows, hardwood forests, marshes and swamps. Lowland grasslands were found in the broader bottom lands and along smaller drainageways of the upland prairies. Eastern gamagrass, switch grass, big bluestem, Indian grass, and Canada wildrye were the dominant growth in the loamy lowland meadows. Prairie cordgrass became the important and dominant growth on the wet clay meadows. In areas of frequent flooding and soil deposition, rice cutgrass, Virginia wildrye, reed canary, and red top were of increasing importance.

Another important plant condition was the savannah-like sites found with the shallow-soil upland forests. These grasses were associated with low quality upland forest or Crider soils with fragipans which restrict rooting and the cherty-clayey conditions in Goss soils. The sites supported grasses and forbs having wildlife importance on about 11 percent of the basin. A small but interesting plant community associated with shallow residual soil over limestone and shale ledges occurred on about 3 percent of the basin. This plant community is important in the Ozark-like forested areas where it makes up almost 10 percent of the Goss-Crider-Bardley-Gasconade soil association and 5 percent of the Sampsel-Polo-Winfield-Snead soil associations. This sparse savannah site, with about 20 percent woody plants, was important for wildlife because it served to mix a grass-forb-shrub complex with forested areas.

The eastern part of the basin was dominanted by forest stands. Forested areas of the Middle and Lower Lamine drainage contained many good sites of upland hardwoods. This area of cherty limestone residium is strongly affected by loess deposits associated with the Missouri River. Low producing upland forest sites accounted for about 35 percent of the basin and bottom land hardwoods. Good upland hardwood sites accounted for about 20 percent of the basin. Fair to good oak-hickory sites were found with the Norris-Bolivar-Mandeville-Bates soils in the southwestern corner of the basin. About 60 percent of Post Oak, Clear Creek and Bear Creek Watersheds was upland sites. These sites, derived from sandstone and soft micaeous shales, have enough unrestricted rooting zones that woodlands compete in the rolling and undulating topography.

Hardwoods of the flood plains were intermixed with the bottom land meadows. Concentrations of bottom land forests were found in the narrower stream valleys and adjacent to major streams. Factors influencing species composition of stands were soils, water table and flooding frequency.

The extent of marshes and swamps on the flood plain has not been estimated but certainly did exist adjacent to the Blackwater River. Early 1900 newspaper accounts, reporting the success of waterfowl hunting in the Warrensburg area, indicate a large area of wetland environments. In general appearance a marshland was similar to the lowland prairies. However, there were important species differences caused by longer periods of saturation in which sedges, spike rushes, smartweeds, reed canary grass, rushes and rice cutgrass dominated. Swamps were present since oxbow lakes began to mature. Species of bulrush, cattail, reed, bur reed, arrowhead, water plantain and underwater plants grew in the shallow lakes.

A wide range of vegetation existed. The interrelationship between the forested and prairie areas was a dynamic and temporary condition. Weather and climatic cycles, periodic fires and concentration of wildlife were important forces affecting plant conditions. Periodic fires and terrain are important factors in maintaining a prairie. A broad plain allows more frequent fires covering a larger area while a broken or dissected terrain tends to control the spread of wildfire. Also weather conditions affect the success of a wildfire. When wild grazing animals (buffalo) were concentrated around waterholes, or salt licks, the climax vegetation was continually set back by over grazing thus, favoring the less paltiable woody species. Likewise, in the forest stands, fall browsing of high protein woody vegetation and soil disturbance favored the establishment of herbaceous plants.

b. Present Land Use

The basin includes a total land area of 1,702,300 acres with 991,600 acres in Blackwater Subbasin and 710,700 acres in Lamine Subbasin (Table 19). Land use distribution by basin is 49.7 percent cropland, 24.9 percent pasture and 17.5 percent forest (Figure 12). Cropland is 54.6 percent in the Blackwater Subbasin and 43.0 percent in the Lamine Subbasin (Figure 13). The inventory acreage includes all land except urban and built-up areas and land owned by the state and federal government. The total inventory land is 1,612,100 or 94.7 percent of the basin.

The distribution of land use is illustrated by the three upland and three bottom land soil productivity groups (Figure 14). SPG U_2, the dominant upland soil, accounts for 49.1 percent of the basin. Pasture and hay are raised on 56 percent of this SPG, tilled crops on 33 percent, and forest on the remaining 11 percent. SPG U_1, a less erosive and more productive soil than SPG U_2, has 7 percent in forest and 93 percent in about equal amounts of tilled cropland, haylands and pasturelands. The most erosive soil is SPG U_3. It is predominantly in forest and pasture with only 2 percent in crop production.

The bottom land SPG's occur on 16.5 percent of the inventory land. SPG B_1, the deep medium textured soils, has the highest potential for crop production when flooding is controlled. At present, it is the most heavily forested bottom land SPG with 40 percent in trees. SPG B_2, having wetness and flooding problems, is the dominant bottom land group. Potential crop yields are less than SPG B_1. Cropland amounts to 43 percent, pasture and hayland 29 percent, and forest 28 percent. SPG B_3, having fine textured very slowly permeable soils, has 61 percent cropland, 31 percent pasture and hayland, and 8 percent forest land.

Major land uses are cropland 49.7 percent, pasture 24.9 percent, forest 17.5 percent and miscellaneous and other 7.9 percent.

Table 19.--Present Land Use, Blackwater-Lamine River Basin, Missouri

Land use	Blackwater subbasin	Lamine subbasin	Total basin
	- - - - - - - - - -	-acres - - - - - - - - - -	- - - - - - - - - -
Inventory land			
Cropland	541,400	305,400	846,800
Pasture	231,100	192,200	423,300
Forest	140,700	157,000	297,700
Other	22,600	21,700	44,300
Subtotal	935,800	676,300	1,612,100
Non-Inventory			
Urban and federal	49,500	30,500	80,000
Water	6,300	3,900	10,200
Subtotal	55,800	34,400	90,200
Total	991,600	710,700	1,702,300

Figure 12.--Land Use, Blackwater-Lamine River Basin, Missouri

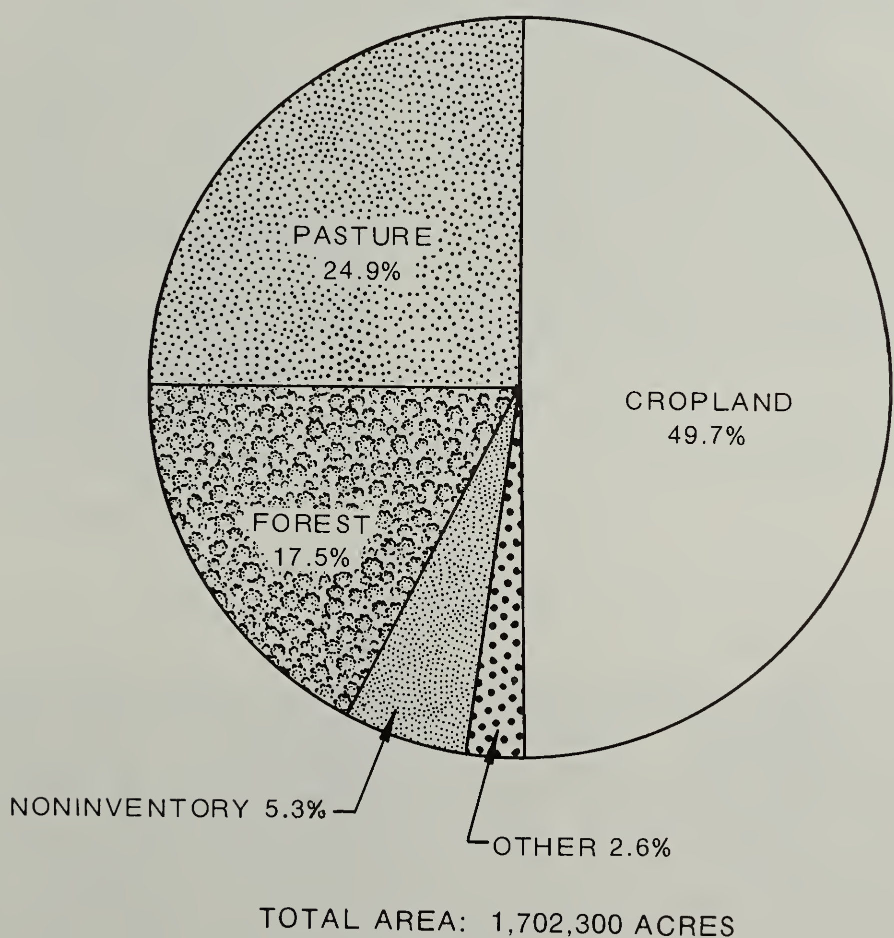


Figure 13.--Land Use, Blackwater-Lamine River Basin, Missouri

A comparison of the inventory land use and net income distribution by upland and bottom land areas illustrates the importance of land use in determining net income (Figure 15). Forest land accounts for 19 percent of the inventory area but only 2 percent of the net income. Land in hay and pasture accounts for 47 percent of the area and 20 percent of the net income. Tilled cropland occupies 34 percent of the area and provides 78 percent of the net income. Although bottom land soils in crops and pasture constitute only 12 percent of the area, they provide 23 percent of the net income from farm products. Additional income from feeding grains and forage to livestock is not considered since it is not tied directly to the resource base.

Figure 14.--Land Use by Soil Productivity Groups, Blackwater-Lamine River Basin, Missouri, 1970

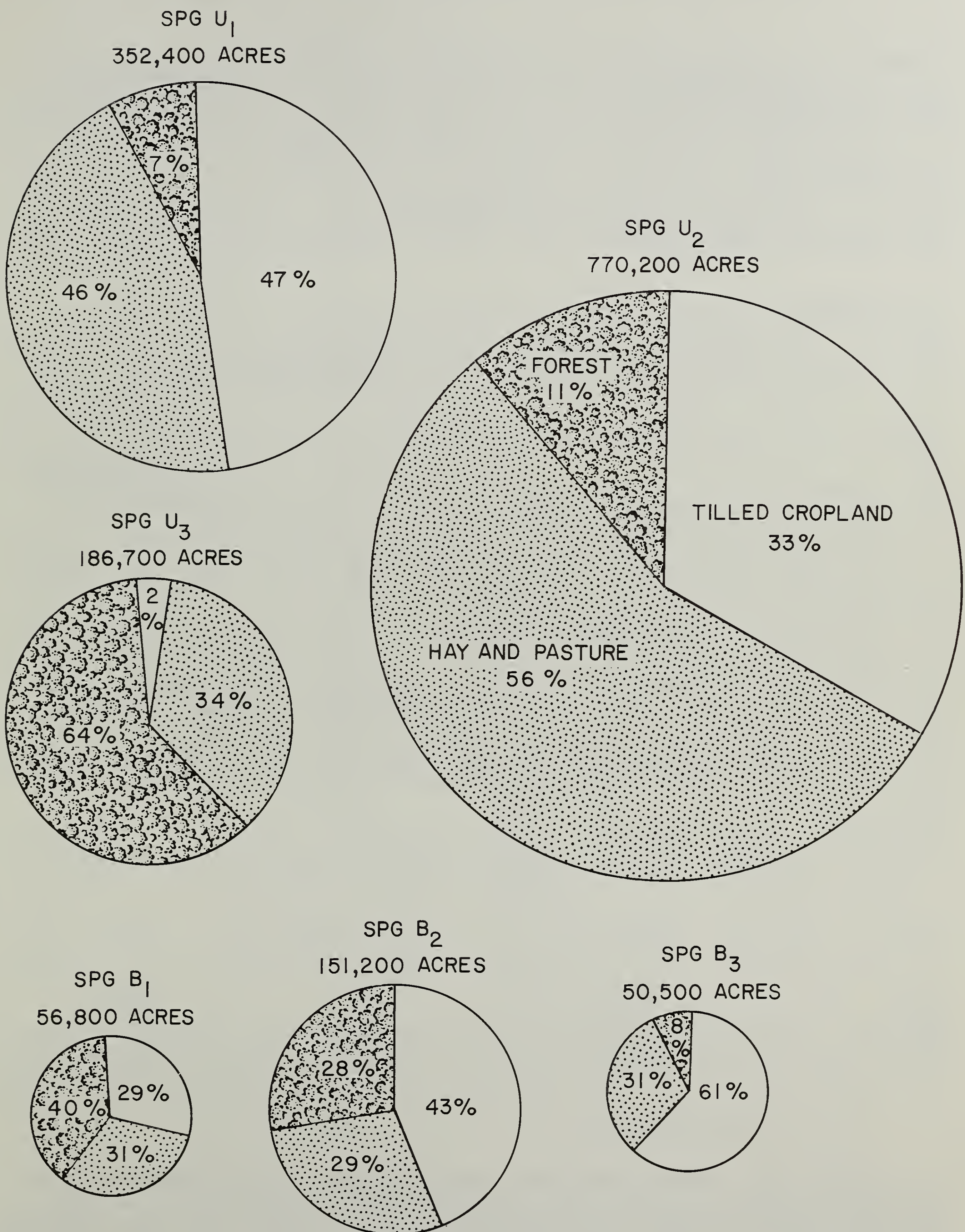
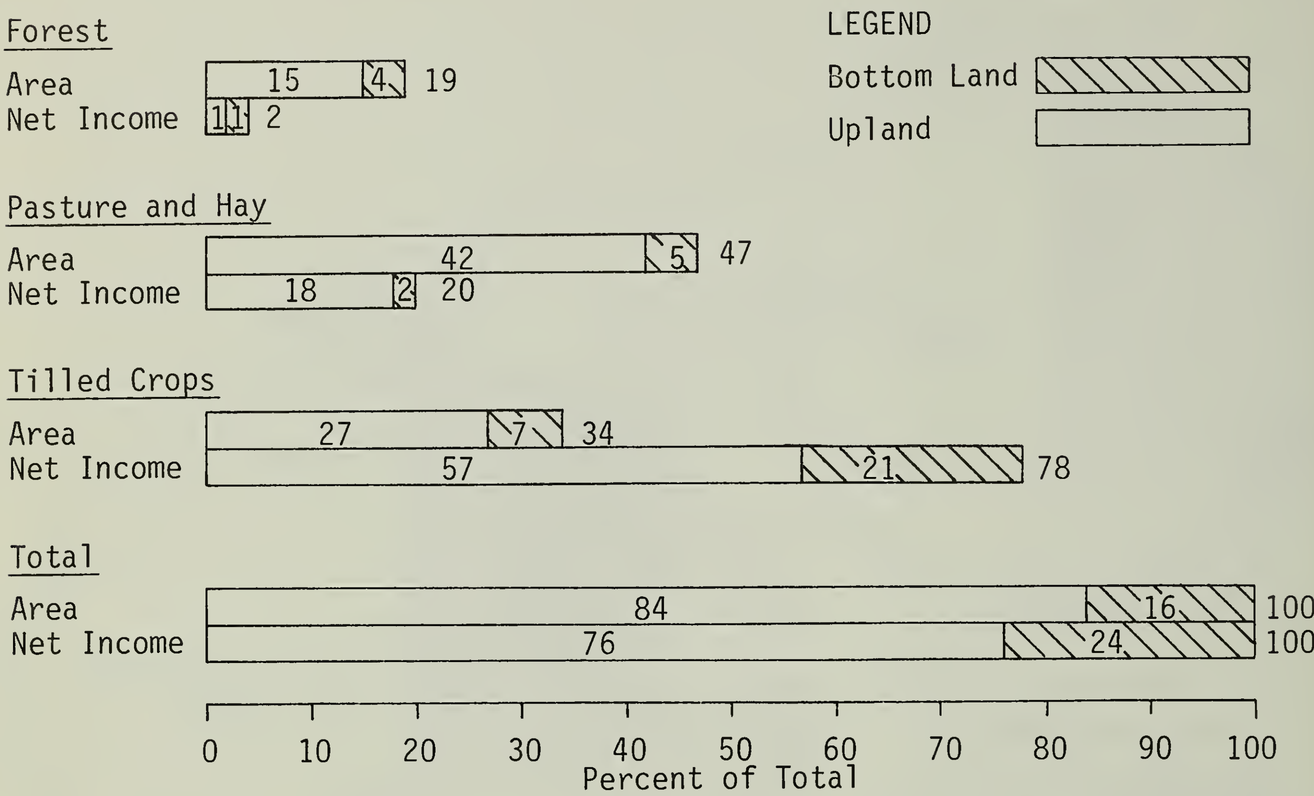


Figure 15.--Percent of Area and Net Income From Upland and Bottom Land by Land Use, Blackwater-Lamine River Basin, Missouri 1970



c. Projected Land Use

The expected increase in population will require more land for urban areas, building sites, roads, and service facilities. These land uses denoted non-inventory are expected to double by the year 2000 and constitute 14 percent of the total land by the year 2020 (Table 20). The area available for food and fiber production and environmental use will be reduced accordingly.

Table 20.--Projected Inventory and Non-Inventory Land, Blackwater-Lamine River Basin, Missouri

Year	Inventory	Non-Inventory	Total
	- - - - - - - - - -	-1000 acres - - - - - - - - - - - - -	
1970	1612.1	90.2	1702.3
1980	1579.9	122.4	1702.3
2000	1526.7	175.6	1702.3
2020	1463.8	238.5	1702.3

5. Forest Resources

Historically forests have been used extensively for grazing livestock and have provided a source of fuel and wood products for use on the farm. The sale of wood products is a source of income. Forest land is an important contributor to recreation, wildlife, aesthetics, erosion control and water

quality. Therefore, benefits from forest land extend beyond the individual owners.

a. Forested Area

Approximately 297,700 acres--17.5 percent of the basin is considered commercial forest land. In non-inventory land, about 7,500 acres are non-commercial forest land. Of the total basin, the Blackwater Subbasin accounts for 140,700 acres of commercial forest land or 47 percent, compared to the Lamine Subbasin's 157,000 acres or 53 percent. About one acre in five is commercial forest land in the Lamine Subbasin, compared to one in seven for the Blackwater Subbasin. The commercial forest land is nearly all in private ownership and the non-commercial forest land is primarily in state, county, and municipal ownership.

Forested acreage has varied through the years. Following World War II, conversion of forest land to pasture and crops was more than offset by areas reverting back to forest land. This occurred in some bottom land areas where channel aggradation results in continuous flooding. In the uplands, gully encroachment in fields causes the land to revert to forest. However, within the last two to three years, forest land has sustained a net loss because of the conversion to crops and pasture.

The Blackwater Subbasin is significantly different than the Lamine Subbasin in forest land patterns and species composition. In the Blackwater Subbasin 34 percent of the forest land is bottom land areas while in the Lamine Subbasin only 14 percent is bottom land. The Lamine Subbasin--especially the eastern half--is typically wooded slopes forested with large contiguous blocks of upland oaks. Conversely, forests occur in scattered tracts in the Blackwater Subbasin. The bottom land forests--extensive prior to channelization early in this century--are still important in terms of area, timber volume, and value (Table 21).

Table 21.--Commercial Forest Land, Blackwater-Lamine River Basin, Missouri

Subbasin	Upland		Bottom Land		Total	
	Acres	Percent	Acres	Percent	Acres	Percent
Blackwater	92,900	66	47,800	34	140,700	100
Lamine	135,100	86	21,900	14	157,000	100
Total	228,000	77	69,700	23	297,700	100

Forested areas currently have a variety of uses including timber production, wildlife, recreation, watershed protection, and grazing. Depending upon the area, some forested lands are being utilized for two or more uses while other areas have a dominant single use.

b. Cover Type

Five basic forest cover types occur within the basin; (1) black oak-Scarlet oak, (2) white oak, (3) hardwood--red cedar, (4) post oak--blackjack oak, and (5) elm-ash-cottonwood-soft maple. Each cover type is determined by species composition and named for the major species. Many other

commercial species, such as black walnut, occur naturally but do not grow in sufficient numbers or volume to be included in one or more of the cover type names.

The cover type elm-ash-cottonwood-soft maple comprises 38.2 percent of the total forest area with black oak-scarlet oak comprising 36.5 percent (Table 22). Generally the black oak-scarlet oak and white oak types occur on well-drained upland soils. The hardwood-red cedar and post oak-blackjack oak types usually are found on the drier ridgetop sites, while the elm-ash-cottonwood-soft maple type is found on the lower slopes and bottom lands.

Table 22.--Forest Cover Types, Blackwater-Lamine River Basin, Missouri

Subbasin	Black oak-scarlet	White oak	Hardwood red cedar	Post oak black-jack oak	Elm-Ash-cotton-wood	Total
			-acres-			
Blackwater	55,300	13,700	- - -	10,000	61,700	140,700
Lamine	53,300	13,200	2,600	35,900	52,000	157,000
Total	108,600	26,900	2,600	45,900	113,700	297,700
Percent of total forest	36.5	9.0	0.9	15.4	38.2	100.0

In the past, forest land, especially in the Lamine Subbasin, was subject to devastating fires and misuse that left it in poor condition. Sustained efforts by the Missouri Department of Conservation to prevent wildfires, encourage proper management of woodlands, and improve cutting practices have begun to correct this situation. With improved fire protection, the volume of sound, young growing-stock has increased until saw-timber acreages now account for 29 percent of the commercial forest (Figure 16). Most of this increase in sawtimber acreage has resulted from the ingrowth of pole stands (6-11 inches DBH). Although stands of sawtimber have increased, less than 50 percent of the forest land is considered adequately stocked with sound commercial tree species.

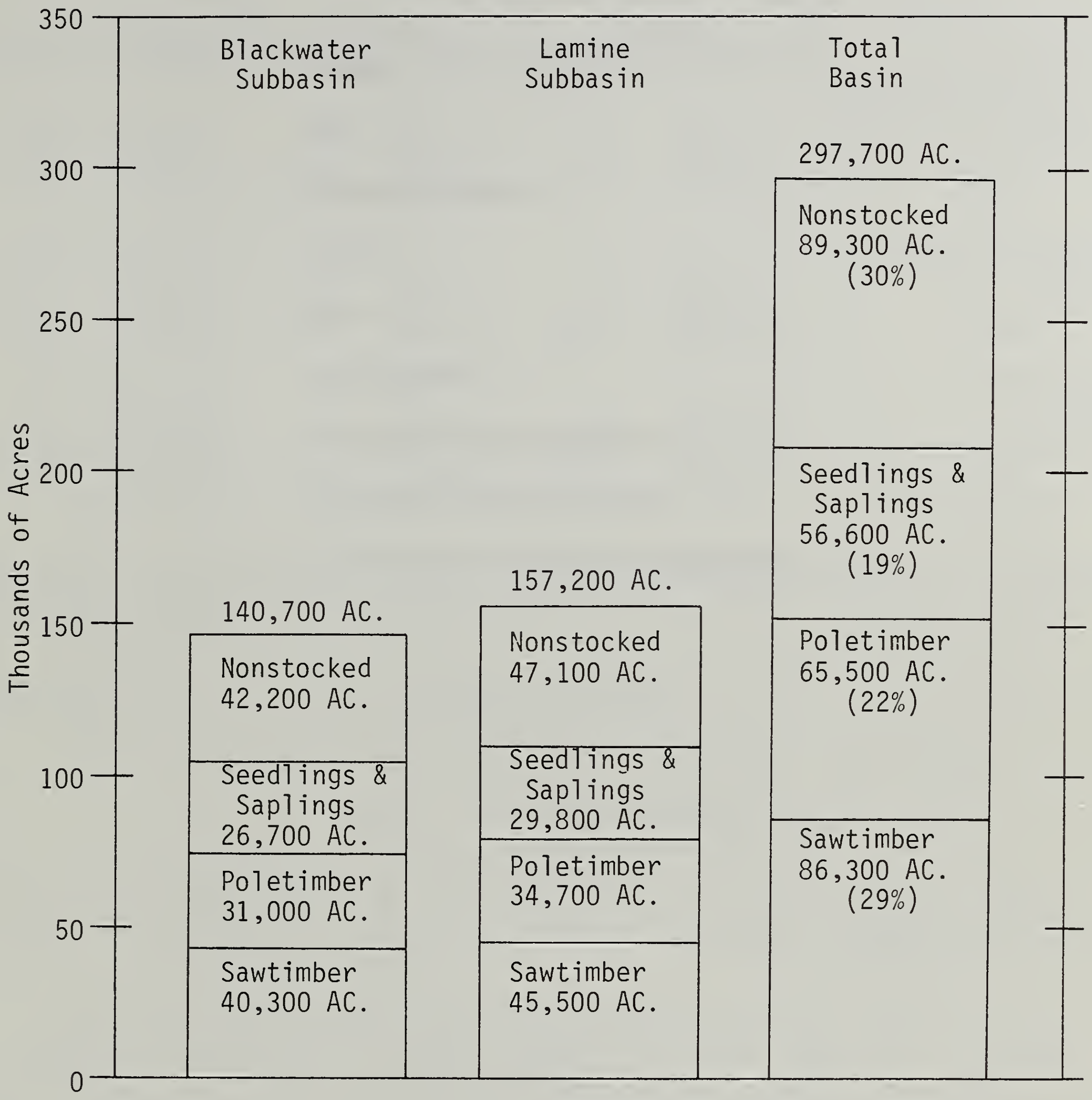
c. Grazing

Livestock grazing occurs on approximately three-fourths of the forest land. On the Blackwater Subbasin, about 66 percent is grazed, whereas on the Lamine Subbasin 83 percent is grazed (Table 23).

d. Timber Production

Annual net growth for all tree species far exceeds the annual desirable cut. The desirable annual cut far exceeds the actual annual cut (Figure 17). This growth and cut comparison indicates an opportunity to increase the actual annual harvest nearer to the annual desirable cut level. Unfortunately, selective cutting increases the complexity. White oak, cottonwood, and possibly black walnut sawtimber are being harvested at rates exceeding desirable levels while elm and other species are far below desirable harvest levels. The size and related quality is another factor. The high quality sawtimber size trees of some species are disappearing while most of the

Figure 16.--Distribution of Commercial Forest Area by Stand-Size Class, 1970, Blackwater-Lamine River Basin, Missouri



growth is occurring on the smaller, lower quality trees. Markets are needed for all species, sizes, and quality of standing timber.

The current annual harvest of soft maple and sycamore comprise nearly 40 percent of the total annual harvest (Table 24 and Figure 18). This is significant because both are essentially bottom land hardwood species. Good markets in and adjacent to the basin have caused some bottom land hardwood species and sizes to be grossly overcut, while more undesirable species are being undercut.

Mill consumption within the basin is about 6.8 million board feet per year with mills in Pettis and Cooper Counties utilizing over 75 percent of the total (Figure 17). Present annual harvest (9,158 MBF), is nearly 2.4

Table 23.--Present Grazing of Forest Land, Blackwater-Lamine River Basin, Missouri

Subbasin	Grazed		Non-grazed		Total	
	Acres	Percent	Acres	Percent	Acres	Percent
Blackwater Subbasin						
Upland	63,500	68	29,400	62	92,900	66.0
Bottom land	30,000	32	17,800	38	47,800	34.0
Total	93,500	66.4	47,200	33.6	140,700	100.0
Lamine Subbasin						
Upland	116,700	89	18,400	70	135,100	86.0
Bottom land	14,100	11	7,800	30	21,900	14.0
Total	130,800	83.3	26,200	16.7	157,000	100.0
Total Basin						
Upland	180,200	80	47,800	65	228,000	76.6
Bottom land	44,100	20	25,600	35	69,700	23.4
Total	224,300	75.3	73,400	24.7	297,700	100.0

Figure 17.--Comparison Between Net Growth, Annual Desirable Cut, and Actual Annual Cut for All Tree Species, Blackwater-Lamine River Basin, Missouri

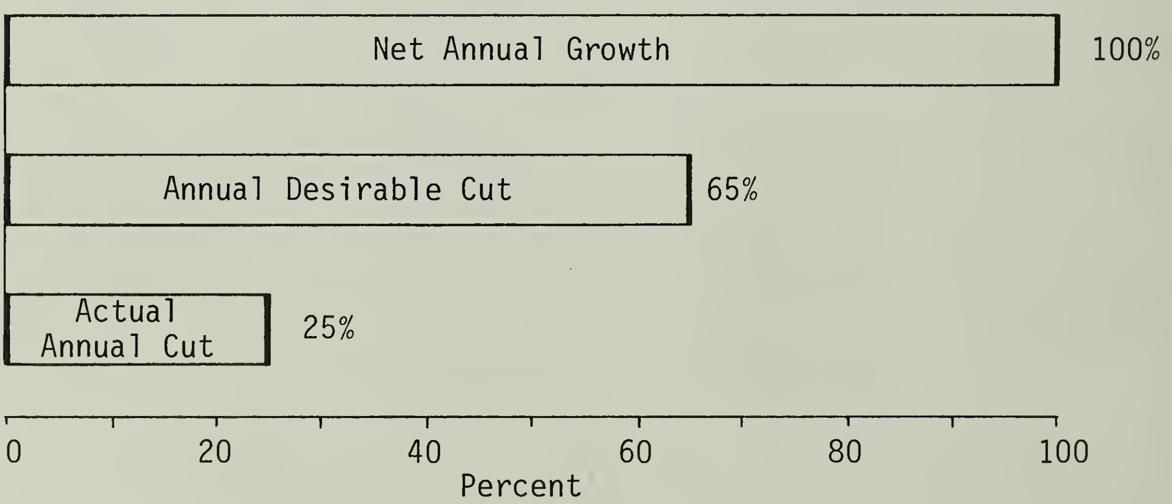
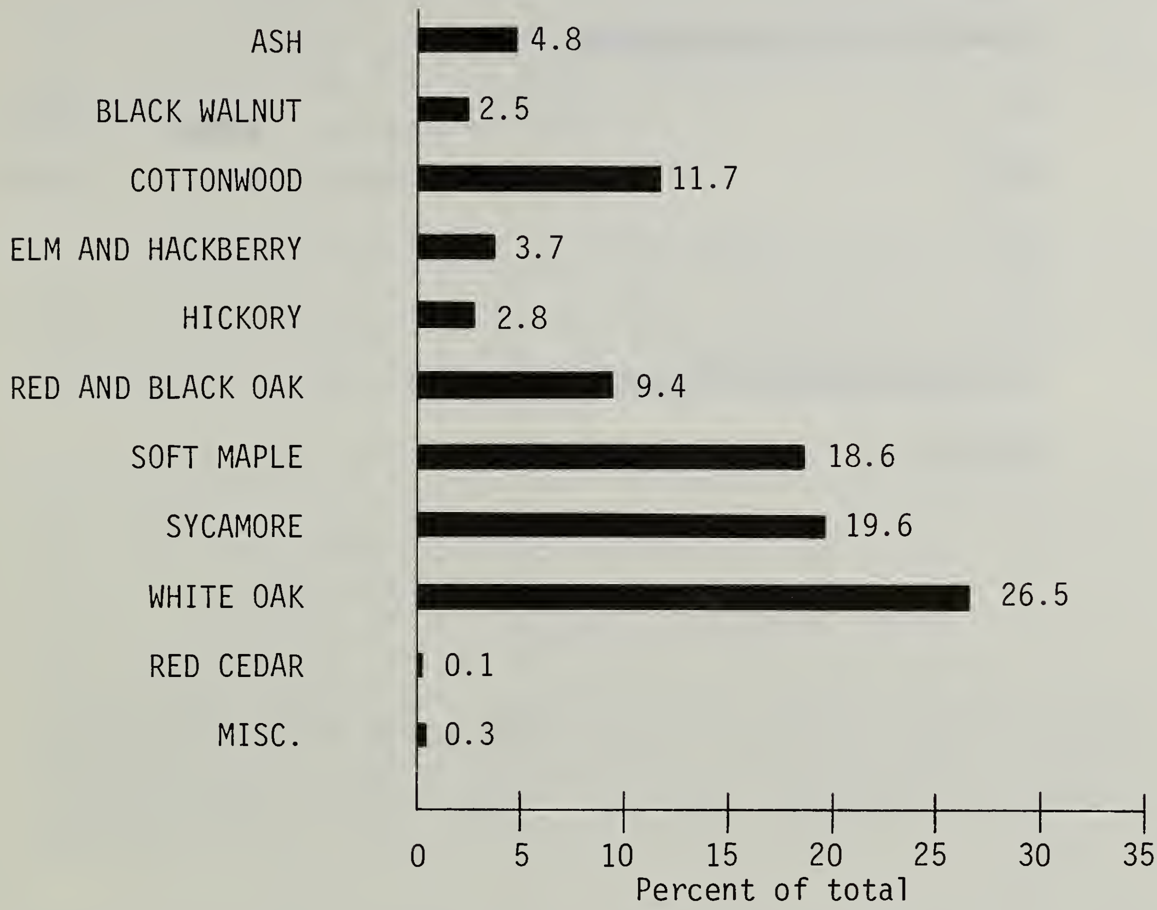


Table 24.--Annual Harvest of Timber, Blackwater-Lamine River Basin, Missouri

Species	MBF 1/	Species	MBF 1/
Ash	437	Soft Maple	1,707
Black walnut	225	Sycamore	1,790
Cottonwood	1,067	White oak	2,431
Elm and Hackberry	337	Red cedar	10
Hickory	259	Misc.	31
Red and black oak	864		
Total			9,158

1/ MBF - Thousand Board Feet

Figure 18.--1970 Timber Production, Blackwater-Lamine River Basin, Missouri



Million board feet higher than mill consumption within the basin. This is because mills from outside the basin process some timber harvested inside the basin (Figure 19). Likewise, mills inside the basin utilize some timber from sources outside the basin.

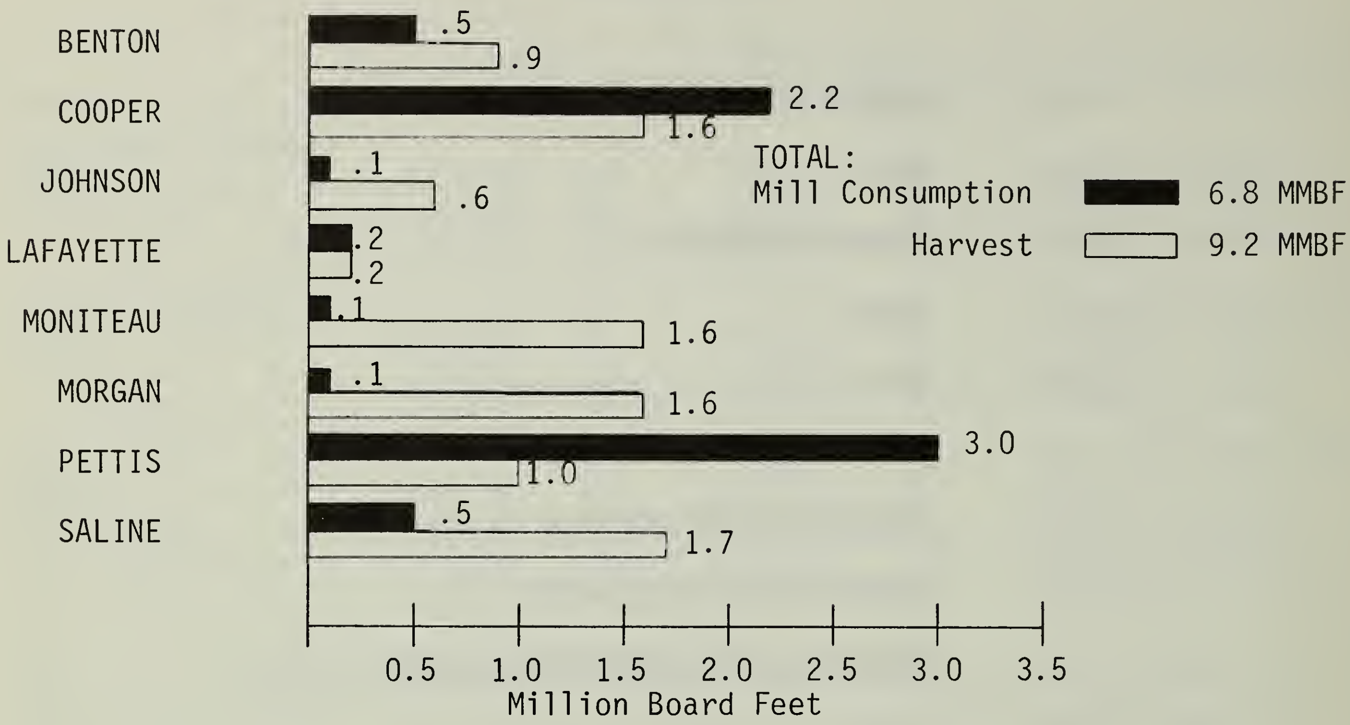
A variety of wood products is produced from the forest lands. Sawlogs are used for lumber, veneer, barrel staves, furniture, gunstocks, railroad ties, and pallets. Pole size material is used for pulpwood, charcoal, shavings, barn poles, fence posts, and other miscellaneous uses. Twenty-nine primary wood-using industries are located inside the basin. However, 61 mills buy timber inside the basin as a part of their total supply. Approximately 300 persons are employed in the primary wood using industries with an estimated income of $2,436,000 annually.

The number of employees in wood product industries is expected to peak by 1980, whereas income is expected to peak by year 2000 (Table 25). Income per person in this industry is expected to rise through year 2020.

e. Forest Wildlife and Recreation

Both the upland and bottom land hardwood stands provide essential food and cover for wildlife. In the northern and western parts of the basin, stringers of timber remaining along the draws, streams and rivers, afford

Figure 19.--Mill Consumption and Harvest, Blackwater-Lamine River Basin, Missouri



necessary travel lanes for many wildlife species. From a total wildlife standpoint, these stringers are more critical and important than the larger, contiguous tracts of forest areas in the southeastern part of the basin. However, this does not lessen the importance of these larger tracts. Wild turkey, grey squirrel, and several other species need the isolation offered by these large tracts.

Although total dollar values of wildlife are difficult to assess, studies have derived values for certain wildlife related activities and species of game. These values were based on the value of a hunter day and represented the estimated cost of a hunter day. The present use of the game species on forest land is approximately 290,000 hunter-days with a value per hunter day of $3.90 or an average of $1.39 for each forested acre annually.

Table 25.--Present and Projected Employment and Income in the Lumber and Wood Product Industries, Blackwater-Lamine River Basin, Missouri

	Year			
	1970	1980	2000	2020
Employees	300	440	428	211
Income (1,000)	1,448	2,314	3,273	2,408
Income/person	4,828	5,260	7,647	11,413

Source: Unpublished data from the Missouri Department of Conservation and OBE-ERS Projections.

6. Water Resources and Use

Water is an important basin resource upon which all life depends. Changes in the use of water resources occur as social and economic conditions vary. The inventory of surface and ground water supplies and uses will provide a base to view future demands and information to guide future resource decisions.

a. Surface Water Supply

The annual rainfall for the west-central plains climatic division varies from a high of 57.72 inches in 1951 to a low of 25.84 inches in 1953 during the period of 1940 to 1970 (Figure 20). Streamflow is a combination of direct surface runoff, spring flow and ground water interflow. Some of the streamflow is stored in lakes and ponds.

Annual runoff yields vary from less than 8 inches in the headwaters of the Blackwater River to more than 10 inches in the headwaters of the Lamine River (Map 12). Data from two stream gages, one on the Blackwater River at Blue Lick the other on the Lamine River at Clifton City, illustrates the month-to-month and the year-to-year runoff from the two subbasins (Figures 20 and 21). During 46 years of record, the annual yield of the Blue Lick Gage has ranged from 0.66 inches per acre in 1957 to a high of 23.04 inches in 1929. Annual yields for the Clifton City Gage during 48 years of record have ranged from 1.65 inches in 1956 to 23.48 inches in 1961. For the years 1953 and 1954, a total 2-year low runoff of 4.90 inches was recorded at the Blue Lick Gage and for 1956 and 1957 the 2-year runoff was 3.61 inches at Clifton City Gage.

Average monthly runoff for both gages is highest from April through June and the lows occur in August. The highest monthly runoff at the Clifton City Gage was 9.29 inches in May 1943 while the highest monthly runoff at the Blue Lick Gage was 8.82 inches in July 1951.

During the month of June, the Clifton City Gage recorded over .5 inch of runoff for 28 years, while the Blue Lick Gage recorded over .5 inch of runoff for 25 years. In comparison during the month of August Clifton City had 13 years and Blue Lick 9 years of runoff amounts exceeding .5 inch.

Annual lake evaporation, on the average about equals annual rainfall falling on the reservoir surface. But, high evaporation losses during periods of high consumptive use and low recharge often occur during the growing season.

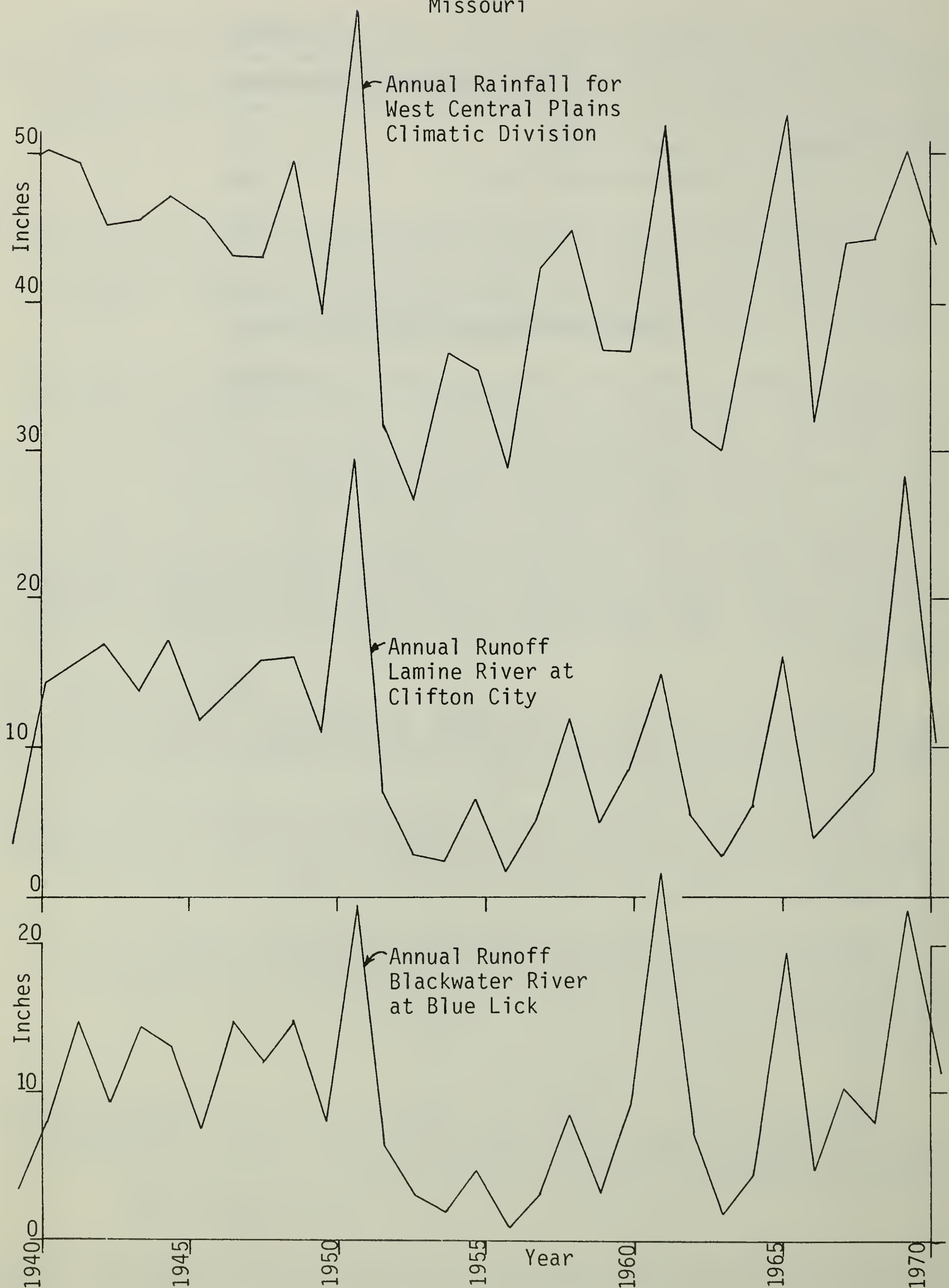
b. Ground Water Supply

Five general areas of ground water resources are delineated which depend upon the geographic location, the depth to the water table, the geologic formation, and the aquifer characteristics (Map 13).

(1) Area A

Wells in Pennsylvanian formations underlying this area yield small quantities of water, usually 3 to 5 gallons per minute (gpm). However, in Saline

Figure 20.--Annual Rainfall and Runoff, Blackwater-Lamine River Basin, Missouri



Map 12.--Average Annual Runoff - Inches, Blackwater-Lamine River Basin, Missouri

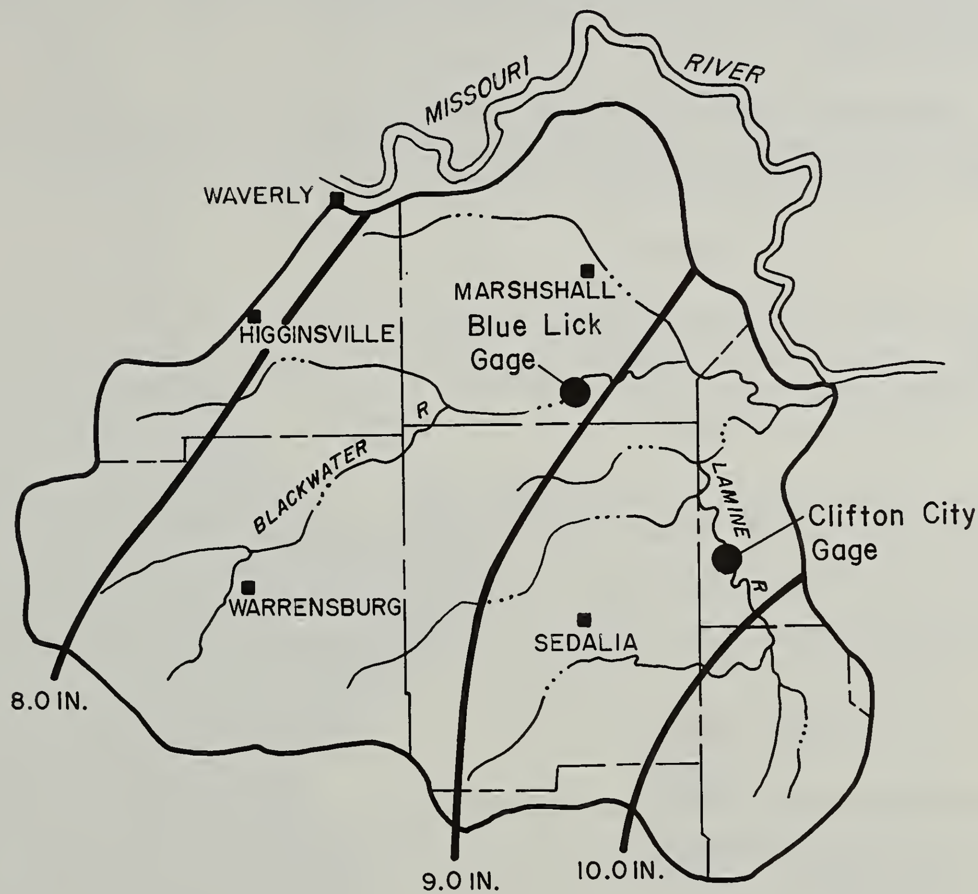
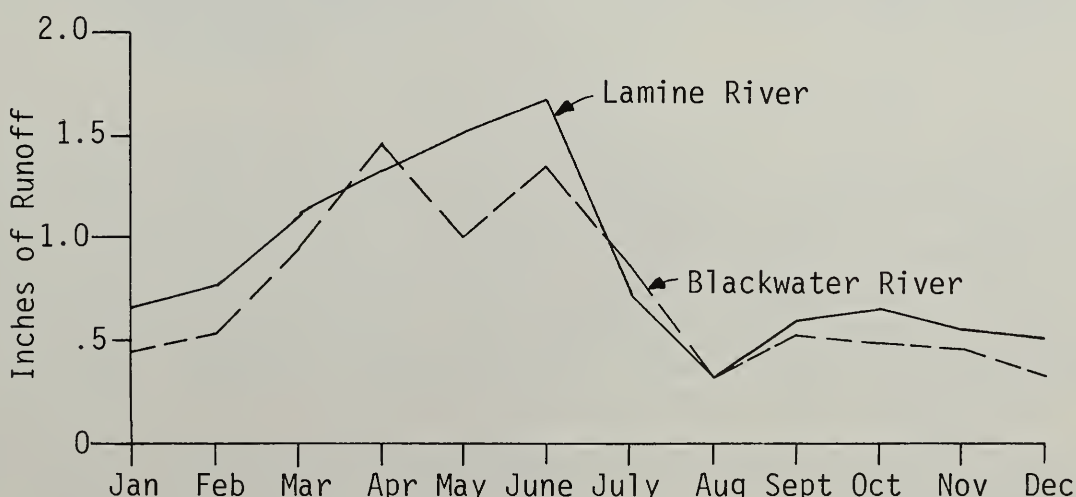


Figure 21.--Average Monthly Runoff for Lamine River Gage at Clifton City and Blackwater River Gage at Blue Lick, Blackwater-Lamine River Basin, Missouri



County, wells in the Mississippian limestones yield as much as 40 gpm locally. Glacial drift in the northern part of Saline County is a locally important aquifer with wells yielding 15 to 20 gpm. Although water from many of the wells meets Missouri Division of Health Standards, mineralized water is frequently encountered.

Water often has total dissolved solids ranging from 1,000 to 5,000 milligrams per liter (mg/l). Chloride concentrations of 250 to 2,200 mg/l are not uncommon and sulfate and iron concentrations may also be high.

(2) Area B

In this area the Pennsylvanian aquifers yield most of the potable ground water except for the Mississippian aquifers in southern Saline County. Wells in Pennsylvanian aquifers yield from 3 to 5 gpm and the Mississippian aquifers yield from 10 to 20 gpm.

The quality of water is variable, since this is a transition area between the sulfo-saline ground water area to the north in Area A and the less mineralized water areas in C and D. Potable water can usually be found in horizons of less than 400 feet. Although ground water is potable, it's total dissolved solids often exceeds the recommendations of the U.S. Public Health Service Drinking Water Standards (500 mg/l).

(3) Area C

The aquifers are composed of Pennsylvania, Mississippian and Ordovician formations. The Roubidoux formation in the western part includes important aquifers of the Ordovician system and the Gunter member of the Gasconade formation in the eastern part. Ground water horizons below the Roubidoux are utilized in the Knob Noster area. Wells in this area yield from 15 gpm to 500 gpm depending on depth and formation.

The total dissolved solids average between 350 and 450 mg/l. Small, localized areas of mineralized water exist along the boundary between Area B and Area C.

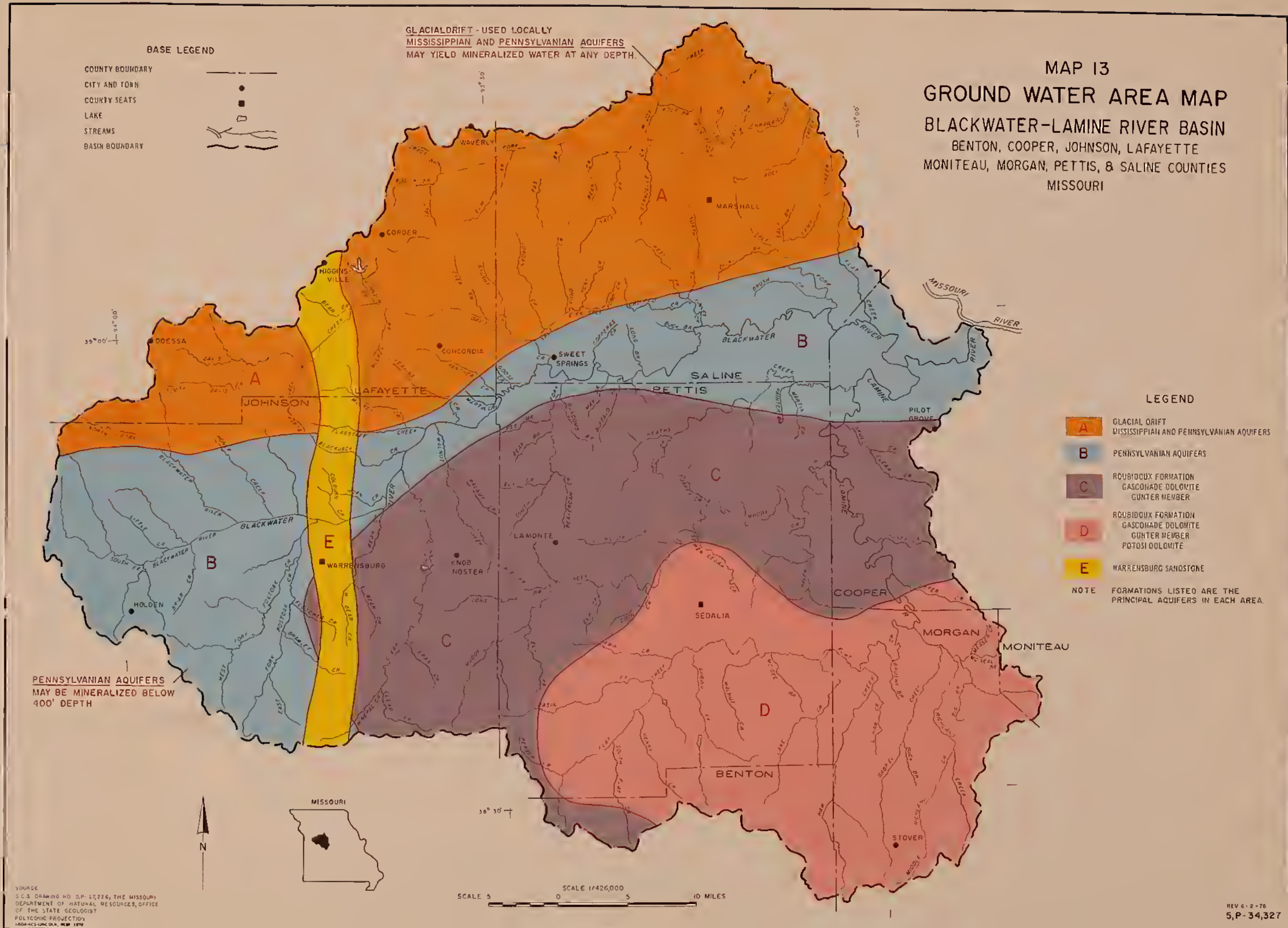
(4) Area D

The principle aquifers include the Roubidoux and Gasconade formations and the Cambrian age Potosi formation. In the Cambrian system, Eminence and Lamotte formations are important local aquifers. The average yields are 20 gpm for the Roubidoux formation. The Gasconade formation yields an average of 15 gpm and the Gunter member 40 gpm. Yields from the Potosi formation range from 250 to 600 gpm and average 400 gpm. Insufficient data are available to determine the yields of wells in the Lamotte formation. However, more than 1,400 gpm have been reported.

The total dissolved solids range from 240 mg/l to 400 mg/l. The yields of wells average 15 gpm.

(5) Area E

The Warrensburg-Moberly channel sandstone is located in this area. The



MAP 13
GROUND WATER AREA MAP
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
BASIN BOUNDARY
GLACIAL DRIFT - USED LOCALLY
MISSISSIPPIAN AND PENNSYLVANIAN AQUIFERS
MAY YIELD MINERALIZED WATER AT ANY DEPTH.
PENNSYLVANIAN AQUIFERS
MAY BE MINERALIZED BELOW
400' DEPTH
LEGEND
A GLACIAL DRIFT
MISSISSIPPIAN AND PENNSYLVANIAN AQUIFERS
B PENNSYLVANIAN AQUIFERS
C ROUBIDOUX FORMATION
GASCONADE DOLOMITE
GUNTER MEMBER
D ROUBIDOUX FORMATION
GASCONADE DOLOMITE
GUNTER MEMBER
POTOSI DOLOMITE
E WARRENSBURG SANDSTONE
NOTE FORMATIONS LISTED ARE THE PRINCIPAL AQUIFERS IN EACH AREA.
WAVERLY
CORDER
MARSHALL
HIGGINSVILLE
ODESSA
CONCORDIA
SWEET SPRINGS
SALINE
LAFAYETTE
JOHNSON
PETTIS
PILOT GROVE
MISSOURI RIVER
BLACKWATER
LAMONTE
KNOB NOSTER
WARRENSBURG
HOLDEN
SEDALIA
COOPER
MORGAN
MONITEAU
BENTON
STOVER
MISSOURI
N
SCALE 1/426,000
SCALE 5 0 5 10 MILES
SOURCE
S.C.S. DRAWING NO. 5,P-17,226, THE MISSOURI
DEPARTMENT OF NATURAL RESOURCES, OFFICE
OF THE STATE GEOLOGIST
POLYCONIC PROJECTION
5,P-34,327

yields from wells average 15 gpm.

Total dissolved solids range from 325 to 380 mg/l. Locally, mineralized water is occasionally encountered. These pockets are completely isolated and have no relationship to the adjacent water. The water is usually acid with total dissolved solids of 3,000 mg/l or more and a high content of sulfate and iron.

c. Water Use

The southern and eastern portions of the basin rely on ground water for domestic purposes. Cisterns are not uncommon in the western and northern areas. Some water is hauled to rural residences from neighboring municipal sources. This is the result of low ground water yield or the high mineral concentrations generally present in the higher yielding aquifers.

(1) M&I and Rural Water Supply

Reservoirs are the only source of water for Concordia, Emma, Holden, Odessa, Higginsville, Corder and Alma (Table 26). Sedalia pumps surface water from Flat Creek, water stored in Spring Fork Reservoir, and supplements this by wells. Water supply for Sweet Springs is obtained from the Blackwater River. Off channel storage is provided to hold water through low flow periods. A population of about 37,000 is served from surface water supplies. Capacity of these systems is about 9.78 million gallons per day. Water for livestock is provided by streams and small ponds. Water consumption from ponds is negligible when compared to the annual supply available.

Table 26.--Public Surface Water Supply 1/, Blackwater-Lamine River Basin, Missouri

County	Town	Present Source	m.g.d.
Pettis	Sedalia	Flat Creek, Reservoirs and Wells	6.50
Lafayette	Alma	Reservoir (Higginsville)	- -
Lafayette	Concordia	Reservoir	.72
Lafayette	Corder	Reservoir (Higginsville)	- -
Lafayette	Higginsville	Reservoir	1.12
Lafayette	Odessa	Reservoir	.72
Johnson	Holden	Reservoir	.43
Saline	Emma	Reservoir (Concordia)	- -
Saline	Sweet Springs	Blackwater River	.29
		TOTAL	9.78

1/ Source: Census of Public Water in Missouri

Twenty-four cities and towns obtain their water from ground water (Table 27). The total capacity of these systems are approximately 10.27 m.g.d. The population served is approximately 38,000.

Sixteen towns with a population of 1,109 do not have municipal water. Their primary source of potable water is individual wells.

Table 27.--Public Well Water Supply From Ground Water Sources 1/, Blackwater-Lamine River Basin, Missouri

County	Town	Present Source	m.g.d.
Pettis	Houstonia	Well	.22
Pettis	Hughesville	Well	.09
Pettis	Green Ridge	Well	.35
Pettis	LaMonte	Well	.40
Pettis	Smithton	Well	.13
Benton	Ionia	Well	.09
Morgan	Stover	Well	.20
Morgan	Syracuse	Well	.14
Moniteau	Fortuna	Well	.18
Lafayette	Waverly	Well	.22
Johnson	Centerview	Well	.02
Johnson	Chilhouwee	Well	.04
Johnson	Kingsville	Well	.03
Johnson	Knob Noster	Well	.45
Johnson	Leeton	Well	.24
Johnson	Warrensburg	Wells	2.44
Saline	Blackburn	Well	.03
Saline	Marshall	Well	4.00
Saline	Mt. Leonard	Well	.04
Saline	Nelson	Well	.07
Saline	Slater	Well	.55
Cooper	Blackwater	Well	.06
Cooper	Otterville	Well	.11
Cooper	Pilot Grove	Well	.17
		TOTAL	10.27

1/ Source: Census of Public Water Supply in Missouri.

(2) Irrigation

Irrigation is not very significant. Its present use is generally limited to small areas. The primary limiting factor is the availability of water, as wells generally do not yield enough water. Surface-storage is normally necessary for irrigation water. Sites are available in most areas. One farm in Johnson County is presently irrigating 320 acres from a surface water source. The Midcontinent Farmers Association research farm in Saline County irrigates seed plots from two small reservoirs.

In most years the rainfall is adequate for good crop yields. Supplemental irrigation during the drought years would increase crop yields. Total rainfall for July and August can be expected to be less than 3.9 inches one year out of ten. In 40 years, 101 dry periods lasting two weeks or more have occurred in the growing season from May through August. Of these, 58 occurred in July and August. Dry periods exceeding 3 weeks occurred 41 times. The annual consumptive use of water for corn of 12.2 inches usually exceeds the rainfall for the months of July and August.

A potential for the development of supplemental irrigation exists especially on Class II land. Approximately 843,910 acres of land is suitable for irrigation (Table 28). Most soils are best adaptable to sprinkler irrigation.

Reservoirs provide water for municipalities, recreation, fishing, livestock and an increasing amount for irrigation.

Table 28.--Irrigation Potential - Land Limitation, Blackwater-Lamine River Basin, Missouri

Subbasin	Total inventory land	Crop and pasture	Irrigation potential 1/
	- - - - - - - - - - - -	- acres -	- - - - - - - - - - - - -
Blackwater	935,800	489,390	535,490
Lamine	676,300	260,950	308,420
Total	1,612,100	750,340	843,910

1/ Land Suitable for Irrigation, Limited to Soils and Slope.

The average volume of runoff leaving the basin is about 1,299,580 acre-feet annually. Of this total the Lamine discharges 595,060 acre-feet and the Blackwater discharges 704,520 acre-feet. Net irrigation requirements for corn are about 1.5 acre-feet of water per acre. The potential irrigable acres are limited by water available from runoff that can be stored (Table 29).

Table 29.--Irrigation Potential - Water Limitation, Blackwater-Lamine River Basin, Missouri

Subbasin	Depletion of average annual runoff			
	25%	50%	75%	100%
	- - - - - - - -	- - - - - - - -acres	- - - - - - - -	- - - - - - - -
Blackwater	117,420	234,840	352,260	469,680
Lamine	99,180	198,350	297,530	308,420 1/
Total	216,600	433,190	649,790	778,100

1/ Limited by Availability of Land.

Although irrigation has been considered a marginal investment in the past, it may be feasible in the future. As technology and management levels are improved and better seed varieties, fertilizers and herbicides are used, the limiting factor may be water deficiencies. If irrigation became a prevalent practice under improved technology and management, water availability may become the limiting factor. The 843,910 acres are potentially irrigable and average annual runoff, assuming 1.5 acre-feet per acre, would only be sufficient for 728,100 acres. No projection has been made for irrigation storage or water use because of these unknown factors.

(3) Water Quality and Wastewater Treatment

The surface water quality in the Lamine River drainage area varies with the source. In the Lamine River, upstream from its confluence with the Blackwater River, the water is moderately mineralized and fairly uniform in composition. Calcium, magnesium and bicarbonate are the principle constituents. The dissolved-solids content ranges from 122 to 278 mg/l, and the hardness of the water ranges from 112 to 271 mg/l which is lower than state standards of 500 mg/l.

Water in the Blackwater River is variable in both dissolved-solids

content and type. The dissolved solids range from 189 to 1500 mg/l with the higher values occurring during periods of low flow. The streams receive inflow from saline springs and during periods of low flow the water has a high sodium chloride content. The sulfate content of the Blackwater River is higher than the Lamine River and on occasion approaching 100 mg/l.

Systems for treatment of animal wastes have also been constructed to meet water quality standards (Table 30). These systems are lagoons constructed to insure that direct discharge into surface or subsurface waters does not occur. The systems are designed and managed to collect and distribute wastes on land in a controlled manner. Letters of approval must be obtained from the Clean Water Commission for construction and operation of animal waste systems.

Table 30.--Animal Waste Management, Blackwater-Lamine River Basin, Missouri 1/

	Approval to construct		Approval to operate	
	Number of permits	Number of animals per year	Number of permits	Number of animals per year
Hogs	23	14,081	16	14,100
Beef	1	2,500	1	425
Dairy	8	790	5	725

1/ April 1974

Streams provide the outlet for discharges from municipal, industrial and agricultural treatment facilities. These discharges must meet water quality standards for each stream established by the Missouri Clean Water Commission. Permits are issued to provide treatment in 30 municipalities, 21 secondary and 9 individual systems (Table 31). Twenty-three industrial waste discharges are listed (Table 32). Of these, 18 used lagoons, 1 aerobic digestion, 2 septic tanks, and 2 settling basins.

7. Fish and Wildlife 1/

Hunting and fishing were the major occupations of the basin proceeding European settlement. The native Americans were Nomadic Indians, as shown by major archeological sites surrounding the area. European settlement occurred during the early nineteenth century. Early accounts give description of bear, elk, wolves, and beaver. By 1840 elk and beaver were gone, and the last bear was killed sometime later. Buffalo fish, catfish, bass, green sunfish, and paddlefish are included in early stream fish population descriptions.

a. Wildlife

Subsistence agriculture was the primary occupation of early settlements. Land use was gradually changed from the presettlement condition by the clearing of the woodlands and the plowing of the prairies.

1/ Missouri Department of Conservation provided inventory material for the Fish and Wildlife Section.

Table 31.--Municipal Waste Treatment Facilities and Discharges, Blackwater-Lamine River Basin, Missouri 1/

Municipality	County	Map 14 location	Type of facility 2/	Design population equivalent	Estimated population served	Receiving stream
		BLACKWATER SUBBASIN				
Alma	Lafayette	13	1C	795	400	Elm Branch
Concordia	Lafayette	17	2-1C	7,056		Davis Creek
Concordia	Lafayette	17	3C	3,740		Panther Creek
Concordia	Lafayette	17	SB			Panther Creek 3/
Corder	Lafayette	12	1C	830	476	Salt Fork Creek
Corder	Lafayette	12	1C	730	476	Salt Fork Creek
Emma	Saline	18	3C	718	250	Davis Creek
Emma	Saline	18	1C	286	250	Trib. to Blackwater R.
Higginsville	Lafayette	11	SB			Maries Creek 3/
Higginsville	Lafayette	11	2C	6,000	2,000	Maries Creek
Holden	Johnson	2	TF	2,500	2,400	Trib. to Blackwater R.
Houstonia	Pettis	20	TF	400		Buffalo Creek
Knob Noster	Johnson	8	1C	6,610	2,300	Clear Fork Creek
Leeton	Johnson	5	1C	345	160	Mineral Creek
Leeton	Johnson	5	1C	200	80	Mineral Creek
Marshall	Saline	21	TF-2C	90,590		Salt Fork Creek
Marshall	Saline	21	SB			Salt Fork Creek 3/
Marshall St. School and Hospital	Saline	21	TF	2,500		Salt Fork Creek
Sweet Springs	Saline	19	1C	2,433	2,000	Davis Creek
Sweet Springs	Saline	19				Blackwater River 3/
Warrensburg	Johnson	6	TF	7,000	4,800	Trib. of Bear Creek
Warrensburg	Johnson	6	TF	7,000	4,200	Post Oak Creek
Warrensburg	Johnson	6	3C	2,742		Blackwater River
Odessa	Lafayette	10	TF		3,000	Davis Creek
Whiteman AFB	Johnson	7	TF		5,400	Clear Fork Creek
Kingsville	Johnson	1	1C			Trib. to Blackwater R.
Centerview	Johnson	3	ST		231	West Fork Post Oak Ck.
Chilhowee	Johnson	4	ST		394	East Fork Post Oak Ck.
Blackburn	Lafayette	14	ST		292	Trib. to Salt Fork Ck.
Malta Bend	Saline	15	ST		338	Salt Fork Creek
Nelson	Saline	25	ST		223	Blackwater River
Blackwater	Cooper	26	ST		249	Blackwater River

Table 31.--Municipal Waste Treatment Facilities and Discharges, Blackwater-Lamine River Basin, Missouri 1/ (continued)

Municipality	County	Map 14 location	Type of facility 2/	Design population equivalent	Estimated population served	Receiving stream
		LAMINE SUBBASIN				
Sedalia	Pettis	30				Flat Creek 3/
Sedalia North	Pettis	30	TF	72,000		Trib. to Muddy Creek
Sedalia West	Pettis	30	TF	36,000		Brushy Creek
Sedalia	Pettis	30	2C	3,500		Flat Creek
Sedalia South	Pettis	30	TF	11,000		Breakfast Branch
LaMonte South	Pettis	9	1C	795	500	Muddy Creek
LaMonte North	Pettis	9	1C	265	300	Blackwater River
Green Ridge	Pettis	28	1C	600	350	Trib. to Basin Fork
Smithton	Pettis	32	2C	620	400	Trib. to Flat Creek
Pilot Grove	Cooper	36	TF	405	350	Trib. to Lamine River
Stover NW	Morgan	34	1C	800		Gabriel Creek
Stover SW	Morgan	34	1C	600		Gabriel Creek
Otterville	Pettis	33	ST		440	Trib. to Flat Creek
Syracuse	Morgan	35	ST		214	Otter Creek
Hughsville	Pettis	31	ST		134	Heath Creek
Ionia	Benton	29	ST		151	Trib. to Flat Creek

1/ May 1975
2/ TF - Trickling Filter
1C - 1 Cell Lagoon
2C - 2 Cell Lagoon
3C - 3 Cell Lagoon
EA - Extended Aeriation
SB - Settling Basin
ST - Septic Tanks
3/ To treat filter backwash of water treatment plant.

Table 32.--Industrial and Small Waste Treatment Facilities and Discharges, Blackwater-Lamine River Basin, Missouri 1/

Name	County	Map 14 location	Type of facility 2/	Design population equivalent	Receiving stream	Flow (Million gal/day)
BLACKWATER SUBBASIN						
Halls Cafe & Service Sta	Saline	38	1C	18		.002 3/
Interstate Producers Livestock Association	Saline	23	2C	530		.05 3/
Olive Mobile Home Park	Saline	22	3C	91	Dicks Branch	.0045 3/
Blind Pony Wildlife Area	Saline	16	1C	17		4/
Bline Pony Wildlife Area	Saline	16	1C	21		.002 3/
Marshall Jct. Holiday Camp	Saline	23	1C	120	Blackwater River	.007 3/
Pointer Service Station	Saline	23	1C	44		3/
Saline County Home	Saline	21	1C	46		.003 3/
Southern Hills Subdivision	Johnson	6	2C	166	West Bear Branch	3/
Johnson County Rest Home	Johnson	6	1C	174		3/
Dellwood Mobile Home Park	Johnson	6	EA	400	Post Oak Creek	.04 3/
North Field Subdivision	Johnson	6	1C	530	Blackwater River	.053 3/
Hickory Hills Addition	Johnson	6	2C	292	Bear Creek	.029 3/
Mobile Home Acres	Johnson	8	1C	218	Clear Creek	.012 3/
Spring Branch Mobile Home Park	Johnson	6	EA	197	Post Oak Creek	.011 3/
Valley View Subdivision	Johnson	6	EA	700	West Bear Creek	.07 3/
Country Acres Subdivision	Johnson	8	EA	152	Walnut Creek	.015 3/
Rolling Hills Subdivision	Johnson	6	3C	525	Bear Creek	.052 3/
Rainbow Acres Subdivision	Johnson	8	3C	275	Walnut Creek	.027 3/
Knob Noster Trailer Park	Johnson	8	2C	205	Walnut Creek	.012 3/
Knob Noster Motel and Restaurant	Johnson	8	ST	15		.0015 3/
Valley Hills Estates	Johnson	8	2C	234	Blackwater River	.023 3/
Vaughn Slaughter and Processing	Johnson	6	1C	67	Blackwater River	.003 6/
I-70 Rest Area	Lafayette	17	2C	159		.015 3/
Nickerson Farms	Lafayette	18	1C	48		.003 3/
Luthern Good Shepard Home	Lafayette				Davis Creek	5/
Schnakenburg Slaughter	Lafayette	17	1C	70	Peavine Creek	.0003 6/
Rustic Acres Motel	Cooper	37	1C	18		.0018 3/
Stuckey's Pecan Shoppe	Saline	24	1C	9		.0006 3/

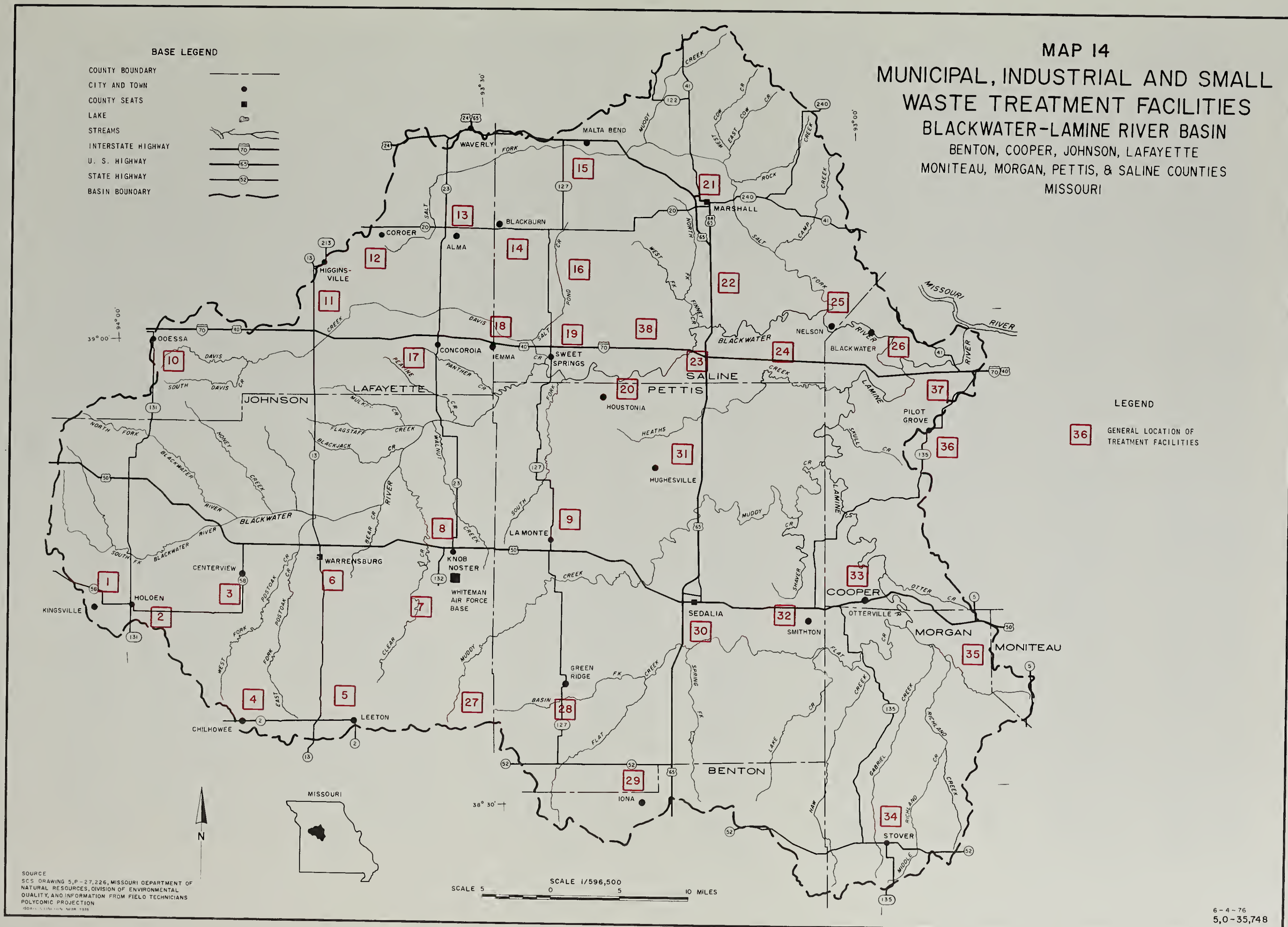
Table 32.--Industrial and Small Waste Treatment Facilities and Discharges, Blackwater-Lamine River Basin, Missouri 1/ (continued)

Name	County	Map 14 location	Type of facility 2/	Design population equivalent	Receiving stream	Flow (Million gal/day)
		LAMINE SUBBASIN				
Pittsburg Corning Corp.	Pettis	30	SB		Brushy Creek	7/
Pittsburg Corning Corp.	Pettis	30			Muddy	8/
Homestead Trailer Park	Pettis	30	1C	80	Sewer Branch	.008 3/
Woody's Trailer Park	Pettis	30	1C	61	Coon Creek	.006 3/
Morris Trailer Park	Pettis	30	1C	39	Flat Creek	.0016 3/
Lee's Novelty Shop	Pettis	30	1C	10	Flat Creek	.0007 3/
Thoma's Restaurant	Pettis	30	1C	55	Muddy Creek	.002 3/
Maplewood Subdivision	Pettis	30	2C	518	Flat Creek	.04 3/
Herrick Rest. & Service Station	Pettis	30	1C	46	Flat Creek	.003 3/
Conalco Conductors	Pettis	30	EA	75	Muddy Creek	.0075 3/
Covered Bridge Manor Mobile Ho.Pk.	Pettis	30	3C	266	Breakfast Branch	.026 3/
South Grand Mobile Home Park	Pettis	30	1C	45	Flat Creek	.002 3/
Sand Man Motel	Pettis	30	1C	44	Flat Creek	.002 3/
Burton Trailer Park	Pettis	30	1C	120	Flat Creek	3/
At&T Relay Station	Johnson	27	2C	9		.0009 3/
Stardust Motel	Pettis	30	1C	50	Flat Creek	3/
Stardust Restaurant	Pettis	30	1C	21	Flat Creek	.0006 3/
High Point Subdivision	Pettis	30	1C	66		3/
Walnut Hills Subdivision	Pettis	30	2C	30	Golf Course Irrigation	3/
Elm Hills Park Development	Pettis	30	3C	494	Irrigation or Flat Ck.	.024 3/
Brentwood Manor & ERDon Villa	Pettis	30	2C	320	Flat Creek	.017 3/
Out Savior Luthern	Pettis	30	1C	35		.001 3/
Crestwood Court	Pettis	30	1C	132		3/
Flat Creek Inn	Pettis	30	1C	30	Flat Creek	3/
Ivy Bend Resort & Restaurant	Morgan	34	ST	25		3/
Koehke Trailer Park	Morgan	35	1C	9	Trib. to Lamine River	.0006 3/
MFA Service Station & Restaurant	Saline	23	1C	40	Dry Creek	.004 3/

1/ May 1975
2/ Same as Municipal
3/ Sanitary
4/ Fish Hatchery
5/ Cooling Water
6/ Slaughter Waste
7/ Process and Wet Scrubber Water
8/ Quarry pit-used for solid waste disposal, occasional storm runoff, discharge is regulated

A variety of upland and woodland wildlife are present for hunting.

(Courtesy - Wooldridge - Missouri Department of Conservation)


MAP 14
MUNICIPAL, INDUSTRIAL AND SMALL WASTE TREATMENT FACILITIES
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
INTERSTATE HIGHWAY
U. S. HIGHWAY
STATE HIGHWAY
BASIN BOUNDARY
LEGEND
36 GENERAL LOCATION OF TREATMENT FACILITIES
LAFAYETTE
JOHNSON
SALINE
PETTIS
COOPER
MORGAN
MONITEAU
BENTON
MISSOURI
ODESSA
HIGGINS-VILLE
COROER
ALMA
WAVERLY
BLACKBURN
MALTA BEND
MARSHALL
NELSON
BLACKWATER
PILOT GROVE
CONCORDIA
EMMA
SWEET SPRINGS
HOUSTONIA
HUGHESVILLE
LA MONTE
KNOB NOSTER
WHITEMAN AIR FORCE BASE
WARRENSBURG
CENTERVIEW
HOLDEN
KINGSVILLE
CHILHOWEE
LEETON
GREEN RIDGE
SEDALIA
SMITHTON
OTTERVILLE
IONA
STOVER
MISSOURI RIVER
BLACKWATER RIVER
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From the agricultural census data for Johnson, Lafayette, Pettis, and Saline Counties, grain crops in the period around 1920 comprised about 40 percent of the land use. Corn, wheat, and oats were the leading crops grown. Woodlands were estimated at 15 percent, haylands at 10 percent and pastures at 35 percent of the land.

The major land use change since 1920 has been a 25 to 30 percent decline in cropland. Small grains have been replaced with forage vegetation. The total acreage of row crops, now including corn, soybeans and grain sorghum, has remained fairly constant at about 26 percent of the basin area.

A decrease in population occurred in several species of wildlife, and prairie chicken populations have continually decreased with the loss of native prairies. The decrease in wildlife is attributed to the increasing farm size, removal of smaller woodlots and clearing of fence rows.

Deer have been reestablished and turkeys are being established successfully. The increase in forest wildlife is attributed to the following major factors; better woodland conditions, stricter harvest regulations, restocking of adapted animals and increased forested area in the Lower Blackwater Subbasin.

Openland wildlife are those species found in a diversified farming economy. Quail and rabbit are the traditional game species. Many other non-game animals are also part of the same environment, but quail and rabbit are the most studied and best understood.

While considered important today as game animals; quail, rabbit, and dove were not a major part of the presettlement wildlife. This is especially true in areas where extensive grasslands or woodlands alone dominated the landscape. The breaking of prairie sod for cultivated crops along with the extension of narrow woody corridors in fence rows and drainage ways extended good habitat into the grassland areas. Upland wildlife prefers landscape that provides a combination of 40-50 percent cropland, 30-40 percent grassland, 10-20 percent woodland, and 10-30 percent idle land. Dove, however, thrives in higher proportions of cropland.

Decreased populations of the larger wildlife species drew attention to the less spectacular quail and rabbit. During the early settlement period, quail and rabbit were not hunted for sport; instead, they were harvested by trapping. Sport hunting began during the first two decades of the 1900's. Rabbits were still hunted mostly for food through the depression years of the 1930's. Commercial marketing of rabbits was a common practice during the 1920's and 30's. As better economic conditions developed, recreational hunting evolved into its present day interest.

Upland wildlife, especially quail and rabbit, are the most sought game species. More recreation days are spent hunting these than any other wildlife. For the 6-year period 1967-1972, about 113,500 hunter-trips were made per year hunting quail, rabbit, and dove. Only squirrel receive as much attention with 40,000 average hunter-trips per year for this 6-year period.

Better openland wildlife habitat is associated with the more diversified farming areas (Map 15). Poorer habitat conditions are found in the more

wooded situations along the Lower Flat Creek, Richland Creek, and Lower Lamine River drainages. The Clear Creek drainage, including Knob Noster State Park, doesn't have enough cropland for good openland wildlife habitat. Poorer habitat conditions are also associated with the intensively farmed Salt Fork Watershed and level divides of the Hartwell-Gerald-Creldon-Eldon soil association.

These conditions are comparable to situations found throughout the state. However, all of the basin has conditions above the statewide medium for rabbit or quail. The entire basin is considered to be the high dove reproducing area of the state.

Wildlife such as deer, squirrel, and turkey are the important game species requiring a largely forested terrain (Map 16). About 20 percent of the basin is presently in woodlands. This compares with about 30 to 35 percent in presettlement periods. The existing forest lands are not distributed uniformly over the basin. The important forest lands are located in the eastern part. Richland Creek, Lower Flat Creek, and Lower Lamine River Watersheds have characteristic border ozark topography and soil conditions. The Goss, Crider, Bardley, Gasconade soil association dominates their land features. Forest lands comprise 36 percent of this association.

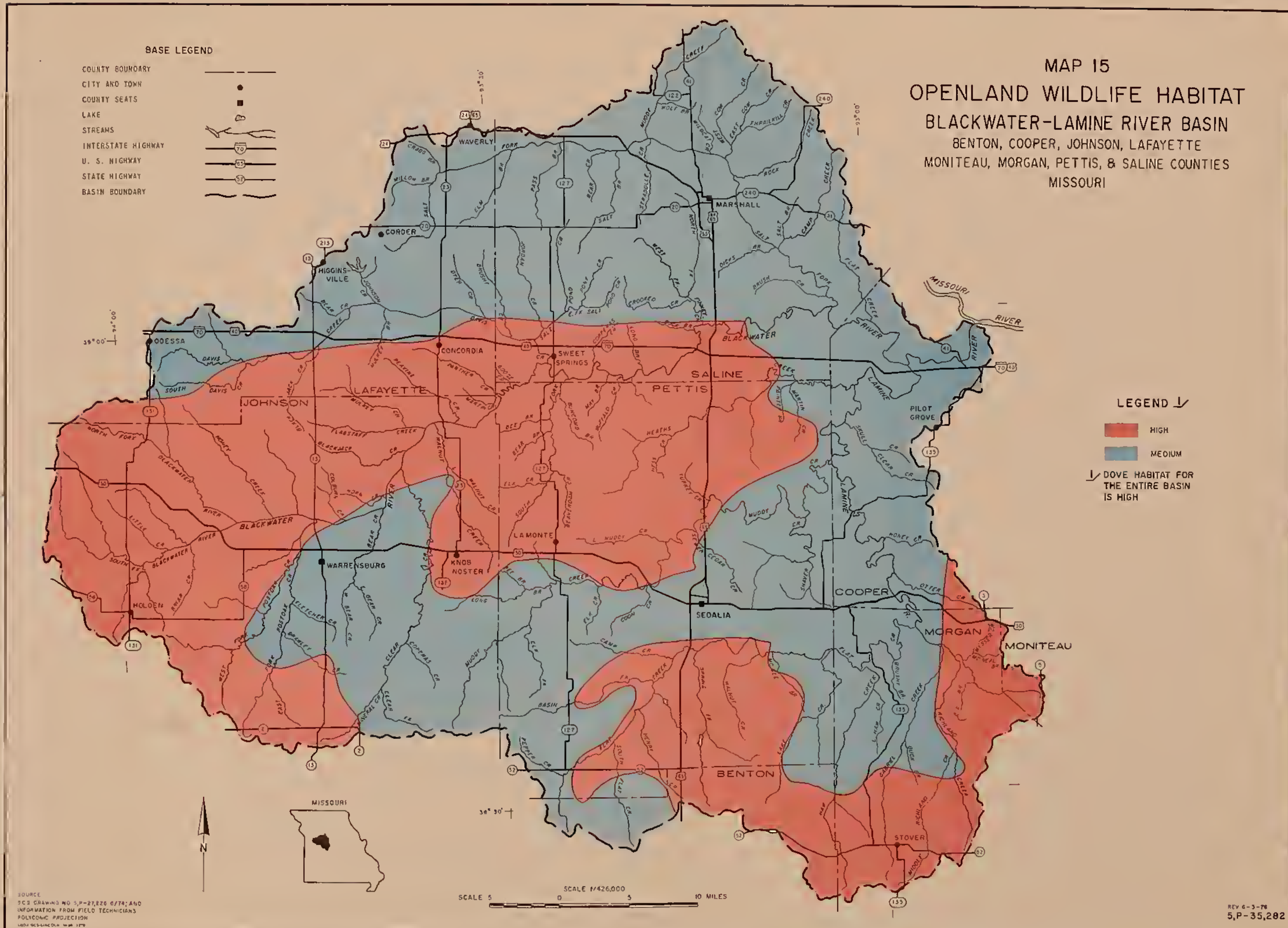
The Blackwater Subbasin is not characterized by significant forest land in the uplands. Deer are associated with the flood plains of the Lower and Middle Blackwater River. The forest land habitat is extended into the higher elevation lands by the wooded breaks and fingers along the tributaries and drainages.

One important area of upland forest occurs in the Clear Creek Watershed of Johnson County. This watershed is dominant by the Hartwell, Haig, Barden, Deepwater soil association with soil and topographic features best adapted to a forested land use. Knob Noster State Park contains a large area of forest land. Its deer population is too high because of inadequate harvest.

The poorest wildlife habitat in forest areas is on the flatter divides and ridge tops between the major drainages. These areas of former prairie situations are intensively cropped and contain only stringers of trees along drainages, odd areas, and fence rows.

Turkey populations have only recently been reestablished by stocking at selected locations. These early reestablishments have been successful and the population is expanding rapidly into adjacent areas. Habitat for turkeys is keyed as to the availability and conditions of the forest lands. Differing from deer, the basin's turkey populations appear to be located on the wooded ridges separating the smaller drainages, especially within the Richland and Flat Creek drainage areas. Nineteen turkeys were harvested during the 1973 spring season. This is not a true picture of the potential. Saline, Morgan and Cooper Counties were open for hunting in the 1973 season.

This basin is valued highly for squirrel hunting. At least 20 percent of the squirrel population is harvested annually. It is estimated that the basin supports more than 50 grey and fox squirrels per 100 forested habitat acres. Best conditions are associated with the Oak-Hickory timberlands predominant in the Lower Flat Creek, Richland Creek, and Lower Lamine River



MAP 15
OPENLAND WILDLIFE HABITAT
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
INTERSTATE HIGHWAY
U. S. HIGHWAY
STATE HIGHWAY
BASIN BOUNDARY
LEGEND 1/
HIGH
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1/ DOVE HABITAT FOR THE ENTIRE BASIN IS HIGH
WAVERLY
MARSHALL
CORDER
HIGGINSVILLE
ODESSA
CONCORDIA
SWEET SPRINGS
SALINE
PETTIS
JOHNSON
LAFAYETTE
PILOT GROVE
LAMONTE
KNOB NOSTER
WARRENSBURG
HOLDEN
SEDALIA
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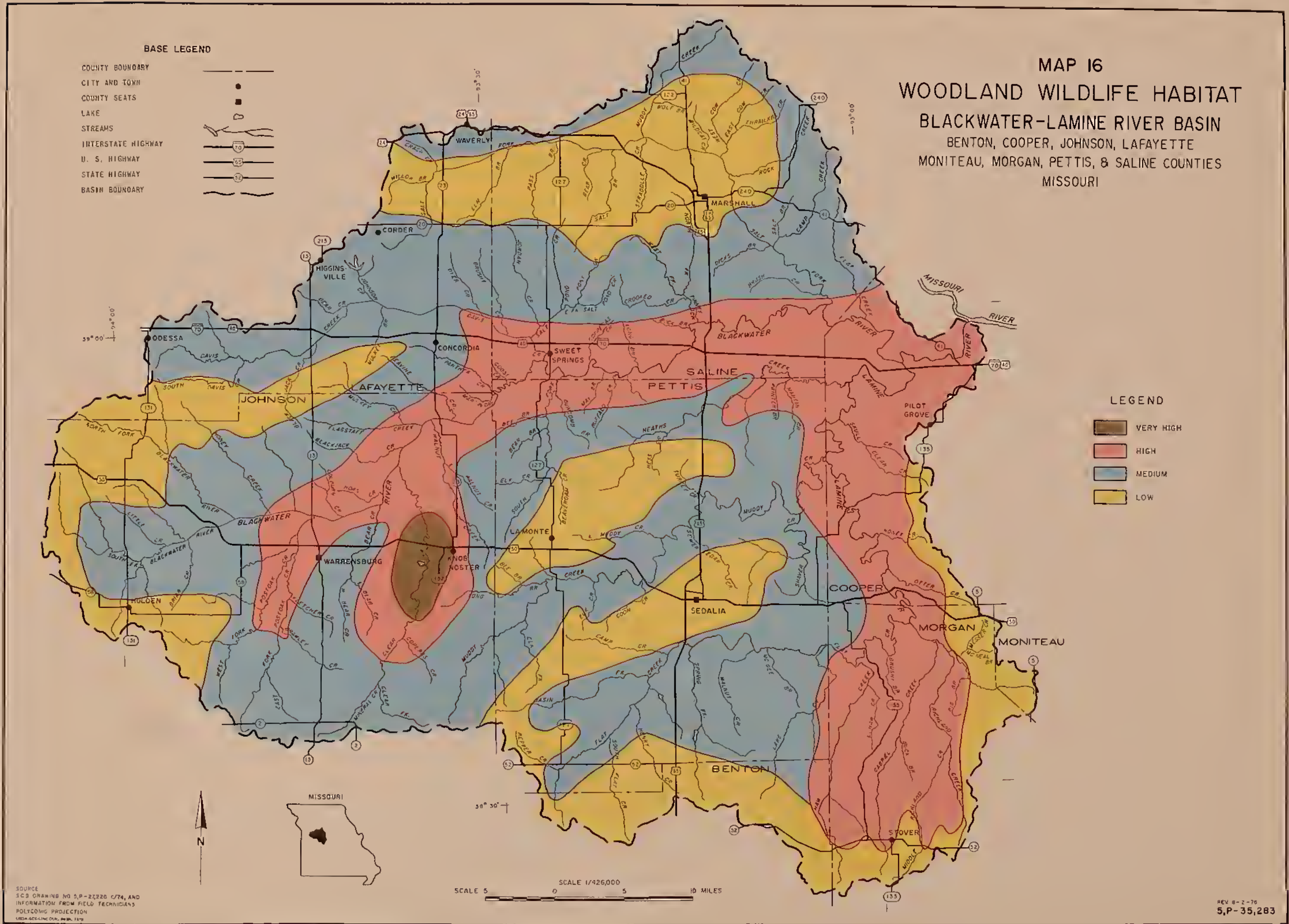

MAP 16
WOODLAND WILDLIFE HABITAT
BLACKWATER–LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
INTERSTATE HIGHWAY
U. S. HIGHWAY
STATE HIGHWAY
BASIN BOUNDARY
LEGEND
VERY HIGH
HIGH
MEDIUM
LOW
LAFAYETTE
JOHNSON
SALINE
PETTIS
COOPER
MORGAN
MONITEAU
BENTON
MARSHALL
WAVERLY
CORDER
HIGGINSVILLE
ODESSA
CONCORDIA
SWEET SPRINGS
PILOT GROVE
WARRENSBURG
KNOB NOSTER
LA MONTE
SEDALIA
HOLDEN
STOVER
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POLYCONIC PROJECTION
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drainages. Squirrel populations of the Blackwater River flood plain are more dependent on agricultural crops for food supplies (Table 33).

Table 33.--Hunting of Woodland Habitat, Blackwater-Lamine River Basin, Missouri

Game	Harvested	Estimated hunters	Hunter-trips
	- - - - - - - - - -	-number - - - - - - - - - -	
Deer (1972)	510	4,000	20,475
Squirrel (Avg. 1967-1972)	69,000	6,715	40,000
Turkey (1972)	19	(No data available)	

Fox and coyote are better adapted to more open conditions, but raccoon and many of the other furbearers are found in lowlands. Furbearers supply an important local recreation and economic resource. Approximately 25,000 furbearers are trapped annually providing about $50,000 to the landowner and trapper. Varmint and predator damage to livestock and poultry is a recognized concern that has diminished in recent years because of fewer farms with sheep and poultry.

The basin is not considered a major attraction for waterfowl in the state. However, its many streams and flood plains have a tendance for spring and fall flooding which attract ducks, especially mallard and wood ducks.

The major lure for ducks during flooding is the mast in timbered flood plains. The average annual duck harvest in 1969-1971 was approximately 12,000 (3 percent of the state total) resulting from 9,500 hunter-trips (2.8 percent of the state total). Geese bagged for the same period averaged 600 annually for 2,150 trips (less than 1 percent of the statewide bag and 1.5 percent of the hunting pressure).

The area north of I-70 along the Lower Lamine and Blackwater Rivers offers the best habitat for waterfowl. It is close to the Missouri River, which maintains large concentration of ducks each winter. Wood ducks are major duck specie. In the period from 1958-72, surveys were made of wood duck reproduction by the Missouri Department of Conservation on 100 miles of Blackwater and Lamine Rivers. The observed nesting efforts per mile average .51 during this period as compared to the statewide average of .39. This indicates that those streams and creeks within the watershed which have not been channelized are important to wood duck production, and because of the abundance of streams, the potential is high.

Occationally the nesting Canada Geese within the basin is reported. Although the number nesting is not large, they sould increase as resident flocks expand their range.

Song birds, shore birds, hawks, reptiles and amphibians are also part of the total biological complex. Because of the complexity and lack of data, details of regarding populations and trends are not available. It is assumed, however, that non-game wildlife will be present if the habitat is provided for game species.

b. Fish

Under present management conditions, 50 percent (5,300 acres) of the 10,600 acres in ponds have some use as a fishery. Public water areas include the 210 acre Blind Pony Lake, 3 small lakes in Knob Noster State Park and the Malta Bend Community Lake. These 5 lakes are managed specifically for public fishing. About 30 percent of the farm pond acreage have been stocked within the last 10 years by the Missouri Department of Conservation. Stocking from private sources, especially of channel catfish, has occurred on many of the other ponds.

Lakes provided fishing mostly for largemouth bass, bluegill and channel catfish. Some of the lakes, especially the larger city reservoirs, provide good crappie fishing. Red ear sunfish are stocked in the Blind Pony Lake.

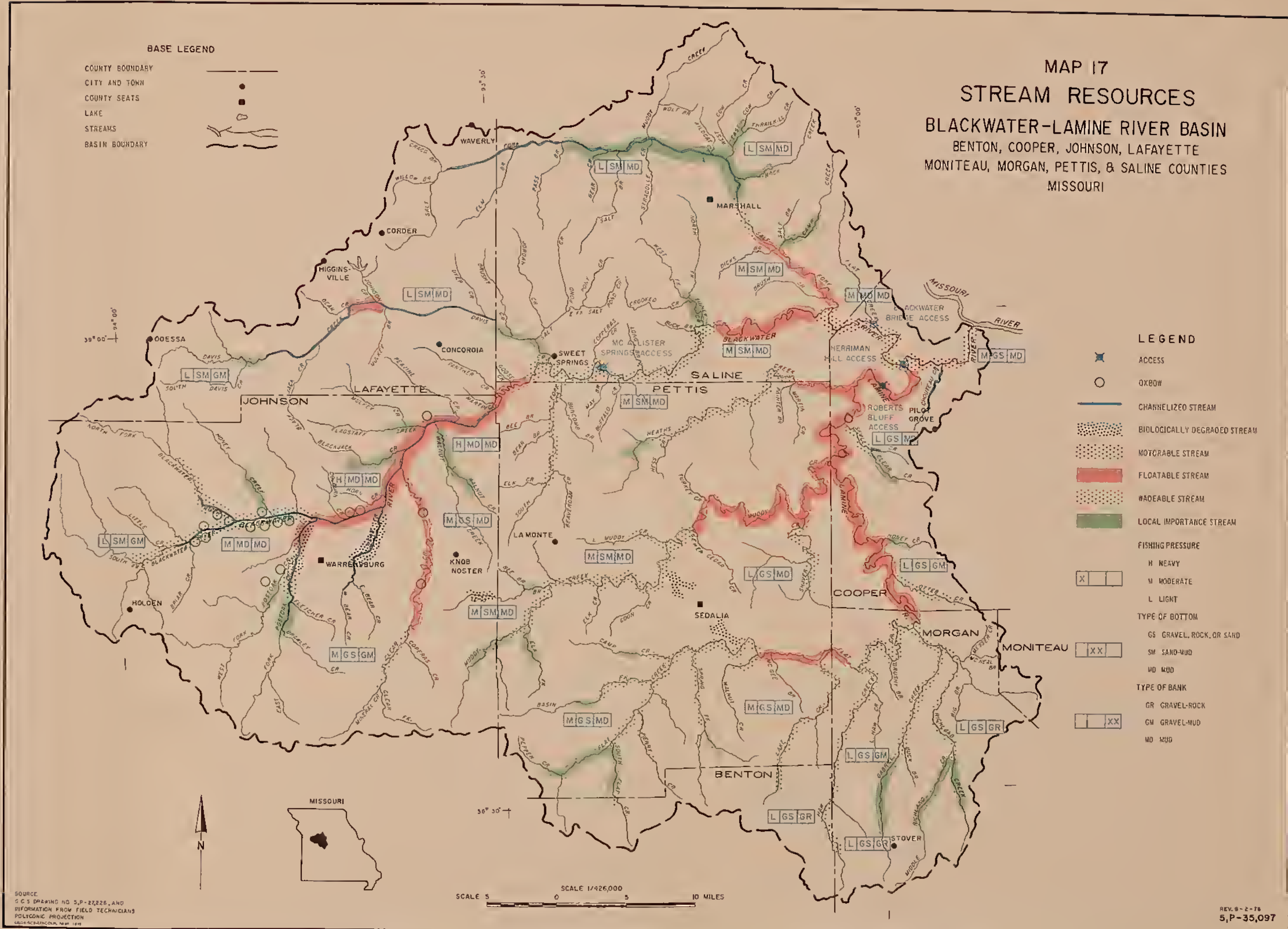
The Stream Resources Map illustrates several conditions of present and potential use (Map 17). Streams generally furnish more recreational activities in the lower reaches. There are 480 miles of streams which have a useable fishery. About 110 miles of the Lamine and Blackwater River can support motor boating and float fishing. Another 70 additional miles could be easily canoed. The other streams furnish important bank or wading type fishing and in some periods of the year could be canoed. Approximately 56 miles of stream are in poor condition because of channelization, or municipal or industrial effluents.

The 480 miles of useable fishery sustain a perennial flow (Table 34).

Table 34.--Streams of Blackwater-Lamine River Basin, Missouri

Stream 1/	Length of perennial flow (miles)	Average surface (acres)
Lamine River	61	770
Richland Creek	28	150
Upper Muddy Creek	17	80
Lower Muddy Creek	46	250
Heath Creek	21	95
Upper Flat Creek	39	210
Lower Flat Creek	53	320
Subbasin Total	265	1,885
Lower Blackwater River	53	425
Upper Blackwater River	66	395
Lower Salt Fork Creek	21	130
Upper Salt Fork Creek	18	65
Post Oak Creek	5	25
Davis Creek	28	240
North Fork-Honey Creek	15	60
South Fork Creek	10	45
Subbasin Total	216	1,385
BASIN TOTAL	481	3,270

1/ Smaller but significant tributary streams are included within these totals.


MAP 17
STREAM RESOURCES
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
BASIN BOUNDARY
LEGEND
ACCESS
OXBOW
CHANNELIZED STREAM
BIOLOGICALLY DEGRADED STREAM
MOTORABLE STREAM
FLOATABLE STREAM
WADEABLE STREAM
LOCAL IMPORTANCE STREAM
FISHING PRESSURE
H HEAVY
M MODERATE
L LIGHT
TYPE OF BOTTOM
GS GRAVEL, ROCK, OR SAND
SM SAND-MUD
MD MUD
TYPE OF BANK
GR GRAVEL-ROCK
GM GRAVEL-MUD
MD MUD
JOHNSON
LAFAYETTE
SALINE
PETTIS
COOPER
MORGAN
MONITEAU
BENTON
WAVERLY
MARSHALL
CORDER
HIGGINS-VILLE
ODESSA
CONCORDIA
SWEET SPRINGS
MC ALLISTER SPRINGS ACCESS
BLACKWATER BRIDGE ACCESS
HERRIMAN HILL ACCESS
ROBERTS BLUFF ACCESS
PILOT GROVE
LA MONTE
KNOB NOSTER
WARRENSBURG
HOLDEN
SEDALIA
STOVER
MISSOURI RIVER
BLACKWATER
LAMINE
MISSOURI
N
SCALE 1/426,000
SCALE 5 0 5 10 MILES
REV. 6-2-76
5,P-35,097

Intermittent flows maintain permanent pools during the year which also have fishery importance. Intermittent flows are important for minnow production and the rearing of young fish. The miles of intermittent flow have not been measured in this river basin.

Stream environments of the Blackwater-Lamine Basin are variable with location. Richland, Haw and Gabriel Creeks are important, quality border Ozark drainages. Game fish include smallmouth bass, largemouth bass and green sunfish. A variety of smaller darter and minnow species are part of the interesting communities present. Fish species taken by fishermen are spotted bass, largemouth bass, flathead catfish, channel catfish, carp, buffalo and carpsucker. Smallmouth bass are taken in upper reaches regularly. Crappie fishing is important during spring season.

Muddy Creek, Heath Creek and Lower Blackwater River depict conditions resulting from a more intensive agricultural activity. These three streams are primarily in their natural condition and provide a capable and productive fishery. Channel catfish carp, buffalo, and carpsucker along with largemouth bass, drum, crappie, green sunfish and black bullhead are the species taken by fishermen.

Upper Blackwater, Davis, Post Oak and Salt Fork are streams adjacent to an intensive agricultural area. Portions of these streams have been altered by straightening. The major straightening and realignment efforts were on the Blackwater River and Davis Creek during the early part of this century. Fish taken consist mostly of channel catfish, carp, carpsucker, drum and flathead catfish. Some largemouth bass and sunfish are taken in the better quality pool areas.

Recent examinations of the stream fishery have been made. Fish fauna were reported by Pflieger of the Missouri Department of Conservation in 1971. Kinds and distribution of fish in the headwater streams were the focus of a study in the summer of 1972. 1/

The two subbasins - Blackwater and Lamine - have important differences as recognized by Pflieger. The Blackwater River is mostly within the Osage Plains while the Lamine is in northwestern edge of the Ozark Uplands.

Pflieger reported 62 fish species in the basin. The Blackwater Subbasin had 27 species while all 62 species were found in the Lamine Subbasin. The 1972 survey, by John Belshe, had 150 collection stations over the basin. He found 54 species. Three species were found that were not previously known, making a total of 65 species for the basin. Thirty-nine were found in the Blackwater Subbasin, 12 more than previously reported. Forty-nine species were found in the Lamine Samples.

1/ Blackwater Lamine Fish Survey, Belshe, John F., Ph.D. of Central Missouri State University.

The twelve most numerous species found in the 1972 survey are listed as follows:

1. Red Shiner, Notropis lutrensis
2. Redfin Shiner, Notropis umbratilis
3. Stoneroller, Campostoma anomalum
4. Creek Chub, Semotilus atromaculatus
5. Green Sunfish, Lepomis cyanellus
6. Sand Shiner, Notropis stramineus
7. Black Bullhead, Ictalurus melas
8. Bluntnose Minnow, Pimephales notatus
9. Common Shiner, Notropis cornutus
10. Bluegill, Lepomis macrochirus
11. Orange Spotted Sunfish, Lepomis humilis
12. Brook Silversides, Labidesthes sicculus

A comparison of the two most common species, red shiner and redfin shiner, reveal a difference between the two subbasins which matches the known habitat preference. Pflieger (1971) and others reported that the red shiner is found more frequently in warm turbid streams with larger pools. This habitat fits situations in the Blackwater Subbasin. In the 1972 survey the red shiner was dominate in 22 percent of the Blackwater compared with 5.6 percent in the Lamine drainages. Likewise, the redfin shiner, preferring streams relatively clear and cool, was dominant in 28 percent of the Lamine and 9.4 percent of the Blackwater.

Game fish, as defined by the Missouri Department of Conservation, were found in 52 of the 150 stations. Channel catfish, Ictalurus punctatus; flathead catfish, Pylodictis olivaris; largemouth bass, Micropterus salmoides; white crappie, Pomoxis annularis; green sunfish, Lepomis cyanellus; bluegill, Lepomis macrochirus; black bullhead, Ictalurus melas; and carp, Cyprinus carpio constitute the important catchable species in the Blackwater Subbasin. In the Lamine Subbasin, spotted bass, Micropterus punctulatus; smallmouth bass, Micropterus dolomieui; and longear sunfish, Lepomis megalotis, are part of the catchable species.

In addition to the fish samples at the 150 stations, physical data were obtained that included temperature, turbidity, dissolved oxygen, carbon dioxide, alkalinity, Ph and percent oxygen saturation. A comparison of these physical data substantiates the habitat differences recognized between the two subbasins (Table 35).

Oxbow and stream cutoff lakes, while not furnishing a great amount of the water resources, are highly productive fisheries and furnish important wetland wildlife habitat. Fourteen oxbows are identified and other smaller areas exist (Map 19). Carp and bullhead are the predominate fish taken while bass, crappie and other sunfish are sometimes taken.

Table 35.--Summary of Physical Data Collected Early Summer 1972, Sample Means by Watershed, Blackwater-Lamine River Basin, Missouri

Parameter	Blackwater Subbasin							Lamine Subbasin				
	South Fork	North Fork	Post Oak	Davis	Upper Blackwater	Salt Fork	Lower Blackwater	Richland	Flat Creek	Lamine	Muddy	Heath
Turbidity	56	30	19	46	4	112	55	6	23	10	44	25
Dissolved oxygen	7.1	6.0	5.8	6.4	4.8	4.8	6.4	6.0	6.8	7.5	6.6	5.3
Cargon dioxide	44	17.2	30.8	12.5	7.9	14.2	12.8	17.2	14.8	8.6	23.6	18.8
Alkalinity	183	110	192	127	165	195	179	195	178	205	139	209
Ph	8.03	7.97	8.33	7.97	6.7	7.29	6.65	7.88	7.92	7.76	7.93	7.75

Commercial fishing operations are grouped into several different enterprises: minnow and gold fish hatcheries, channel catfish producers, fee fishing areas, and bait vendors. About 420 acres of water are devoted to fee fishing, fish farming or minnow hatcheries. A large part of this acreage is in one fish hatchery in Morgan County. Fee fishing lakes are present although no large bodies of water are devoted to them. In 1973, 17 bait vendors provided a dependable supply of bait supplies for local use.

8. Outdoor Recreation Resources

The characteristics of the basin are unique. There are many scenic vistas. The steep hills and narrow valleys of the southeast resemble the bordering Ozarks to the south. The bluffs overlooking Lower Flat, Richland and Gabriel Creek and the Lamine River have aesthetic appeal. The tall grasses and rolling landscape are similar to the prairie to the west. The broad valleys are intensively farmed.

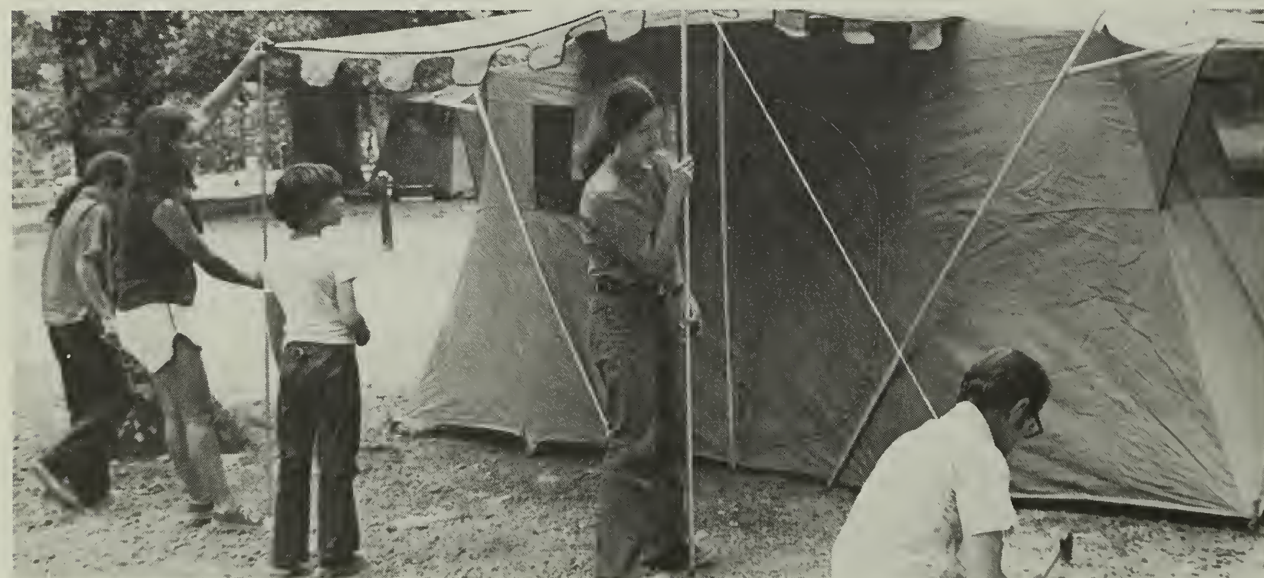
Significant recreation areas which are in close proximity to the Basin are Van Meter State Park, located on the northern border; Arrow Rock State Park, located on the northeastern border; and the Lake of the Ozarks. Harry S. Truman reservoir, under construction, is located about 20 miles south. The Missouri River parallels the northern border of the basin. It becomes an increasingly important recreation source as more access areas are developed.

A recreation inventory of areas and facilities was completed by the Missouri State Inter-Agency Council for Outdoor Recreation in the summer of 1972 (Table 36, and Table 37). Sites inventoried included private commercial areas and areas owned or administered by government agencies or both.

State properties include those administered by the Department of Natural Resources, Division of Parks and Recreation and the Department of Conservation (Table 38, and Map 18). Both Van Meter and Confederate Memorial State Parks are just outside the basin boundaries but have been included.

Fishing, nature trails, swimming and camping are recreation opportunities provided by state and local facilities.

(Photos by Decker - Missouri Department of Natural Resources)



(Courtesy - Wooldridge - Mo. Dept. of Cons.)

Table 36.--Inventory of Recreation Lands, Blackwater-Lamine River Basin, Missouri

Ownership	Area (acres)	Percent
Federal	0	0
State	8,358	73
County	1	0
Municipal	1,818	16
School	335	3
Private Commercial	949	8
Total	11,461	100

Also State Highway Department rest areas and the State Fair Grounds managed by the Missouri Department of Agriculture are included.

Table 37.--Existing Recreational Facilities by Activity, 1/ Blackwater-Lamine River Basin, Missouri

Activity	Units	Existing facilities	
		Amount	Recreation days
Playing outdoor games	acres	316	474,000
Fishing:			
Stream	miles	481	46,400
Impoundments	acres	7,715	226,150
Boating:			
Stream	miles	92	41,400
Impoundments	acres	617	92,550
Water skiing:			
River	miles	15	1,050
Canoeing:			
Stream	miles	70	35,000
Swimming:			
Pools	sq.ft.	44,975	89,950
Beaches	sq.ft.	86,500	86,500
Hunting	acres	4,116	41,160
Camping	acres	116	172,640
Nature trails	miles	77	35,000
Picnicking	acres	251	324,000
Ice skating	sq.ft.	193,400	135,380
Total			1,801,180

1/ Source: Missouri Outdoor Recreation Inventory

Almost all incorporated towns have municipal parks. Most are neighborhood type parks; a few are large enough to be classified as community parks. These parks are the front line for meeting local recreation demand, especially for the very young and old. Almost all the game and athletic type facilities are located in these parks and on school grounds.

Private commercial areas play a role in providing recreation opportunities. They provide both land and facilities for public use. A limited number of private enterprises exist including country clubs, pay-fishing lakes, camping and picnicking areas, swimming beaches, and a speedway

Table 38.--Park Facilities, Blackwater-Lamine River Basin, Missouri

	Area				Boating	Swimming	Fishing	Camping	Picnic	Hunting	Play fields
	Total	Land	Water: Lake	Water: Stream							
	-----acres-----			(miles)							
State Parks											
-1 *Confederate Memorial	108	100	4				●		●		●
-2 Knob Noster	3,511	350	40	15	●	●	●	●	●		●
-3 *Van Meter	794	39	12				●	●	●		●
State Highway Parks											
-4 Waverly Roadside Park	3	3							●		
-5 Otterville Roadside Park	1	1							●		
-6 Concordia Rest Area	15	15							●		
-7 Sedalia Roadside Park	3	3							●		
State Fish and Wildlife Areas											
-9 Malta Bend Community Lake	25	20	5				●				
-10 Herriman Hill Access	12	2					●				
-11 Blackwater Access	5	5					●				
-12 Blind Pony Wildlife Area	1,120	3	210				●		●	●	
-13 Perry Memorial Wildlife	864									●	
-14 Marshall Junction Wildlife	774						●			●	
-15 McAllister Springs Access	5						●				
-16 Roberts Bluff Access	7						●				
-17 de Bourgmond Access	25						●				
-18 Mora Wildlife Area	320						●				
Municipal Parks and Lakes											
-20 Pertle Springs	35	18	15		●		●		●		●
-21 Shepard Park	5	5							●		●
-22 Vermont Park	8	8							●		●
-23 Howsel Park	7	7							●		●
-24 Hubbard Park	28	28				●			●		●
-25 Liberty Park	44	43	1			●	●		●		●
-26 Centennial Park	53	43				●			●		●
-27 Flat Creek	3	3							●		●
-28 Central Park	1	1									
-29 Southside Park	3	3							●		●
-30 Fairground Park	40	40				●			●		●
-31 McCord Park	3	3							●		●
-32 Railroad Park	1	1							●		
-33 Bridges Park	1	1							●		●
-34 Higginsville City Lake	300	80	200		●		●		●		
-35 Odessa Reservoir	409	6	93		●		●				
-36 Edwin A. Pape Lake	305	10	245		●		●		●		
-37 Spring Fork Lake	190	12	178		●		●		●		

* These parks are just outside basin

Table 38.--Park Facilities, Blackwater-Lamine River Basin, Missouri
(continued)

	Area				Boating	Swimming	Fishing	Camping	Picnic	Hunting	Play fields
			Water								
	Total	Land	Lake	Stream							
	-----acres-----			(miles)							
<u>Municipal Parks & Lakes (cont.)</u>											
-38*Brush Creek	51										
-39*Knob Noster City Park	4										
-40*Knob Noster Ball Park	5										
-41*Phillips Park	1										
<u>Civic or Community Parks</u>											
-42 Pilot Grove City Park	4	4				●			●		●
-43 Holden Jaycee's Park	17	16	1				●				●
-44 County Crossroads	1	1							●		
-45 Stover Memorial	20	12						●	●		●
-46 Sweet Springs Memorial Park	56	30	3			●	●	●	●		●
-47 Slater City Park	12	12				●			●		●
-48 Indian Foothills Park	220	219	3			●	●		●		●
-49 Lamonte Community Park	1	1							●		
-50 Hughesville Community Park	6	4	1				●		●		
-51 Howard Park	1	1							●		
-52 Smithton Park	1	1							●		●
-53 Corder City Park	15	15						●	●		●
-54 Alma City Park	8	8							●		●
-55 Waverly Memorial Park	9	9							●		●
-56 Chilhowee City Park	1	1									●
-57 Grover Park	16	16							●		●
-58 Blackwater City Park	5	5							●		●
-59 Fireman's Ball Park	3	3									●
-60 Holden Recreation Club Park	3	3									●
-61 Holden Ball Park & Horse Ring	9	9							●		●
-62 Sweet Springs Fishing Lake	20	10	10				●				

* All land acreage is natural

facility. Boating is common on the Lamine and Blackwater Rivers and on some of the larger lakes. The activities of bicycling, horseback riding, and hiking occur on public and private lands, although no public facilities have been developed.

9. Archeological - Historic Resources 1/

The prehistoric occupation of the Blackwater-Lamine Basin includes American Indian people from early times to the Indians that met the early

1/ Information obtained through the cooperation of the State Historical Survey and Planning Office and a contract with the Director of the Missouri Archeology Survey.

explorers. The Blackwater-Lamine River Basin may be considered one of the most important single basins in Missouri since the prehistoric and historic utilization was intensive and somewhat permanent. Many of the known archeological sites are large and have deep deposits. Deep, thick deposits of cultural debris permit excavation of undisturbed archeological remains even though the area may have been cultivated for many years.

Although no systematic archeological survey has been conducted nor is in progress in the Basin, numerous archeological sites are known and recorded. Also, many are known to exist but are not recorded. With each new investigation of a specific area, new, previously unknown sites are discovered. Significant archeological sites should be expected in this basin. Recent excavations on archeological sites can show that sites are both areally extensive as well as of considerable depth. Most of the known sites occur along river banks, on terraces of the water drainages, and on the tops of hills and bluffs bordering the streams. Known sites are located on tributaries as well as along the main streams.

Perhaps only 10 percent of the prehistoric sites have been located. The Missouri Archeological Survey numbers and maintains a record of sites which are reported. A search of these records show that there are 330 known sites within the Basin. Most of these sites, known only as locations, have been recorded by the Survey over the past 45 years. Some, however, represent sites which have been tested and excavated. These sites are usually reported in manuscripts and publications. Reported sites are not normally verified or revisited periodically so no reliable estimate is available of how many of the recorded, numbered sites still exist.

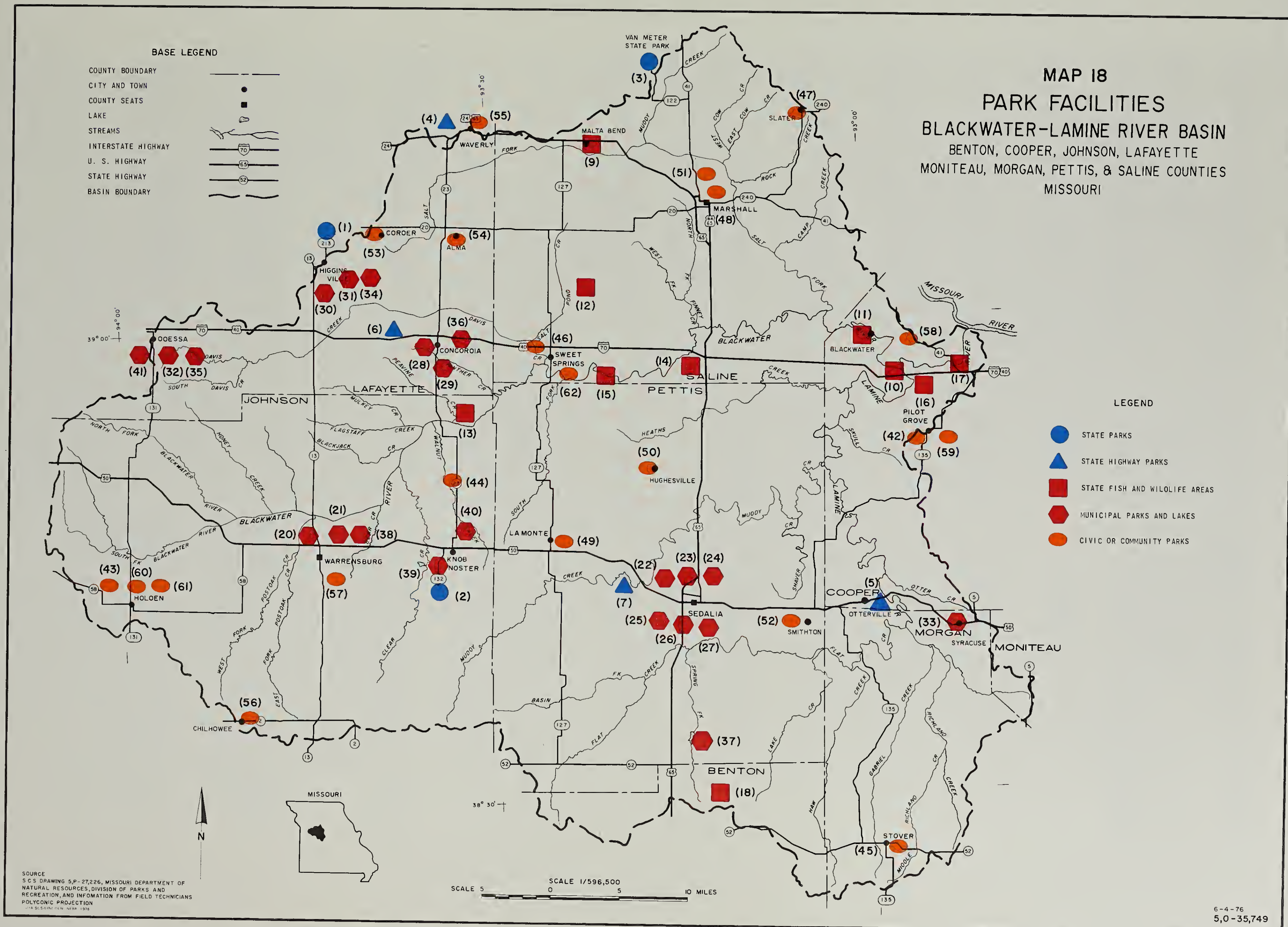
A total of 235 sites are listed in the National Register of Historic Places in Missouri. Eight of them are in the basin. One National Register entry is a building and seven are archeological sites (Table 39).

The Buildings Inventory includes 33 Historic sites not on the National Register of Historic Places (Table 40).

10. Unique Scenic and Natural Areas

The unique scenic and natural areas in the basin are; the natural grasslands, the saline or salt springs, and the undisturbed glade areas associated with the Lamine River Subbasin (Table 41). Missouri Department of Conservation currently has no specifically designated natural areas in the basin.

The Missouri Prairie Foundation has documented native prairie areas throughout the state. About 100 acres of native grasslands remain in Pettis County and small areas remain in Morgan, Johnson and Benton Counties. The Missouri Department of Conservation manages the Mora Wildlife Area, a native prairie tract located on the divide between the Blackwater-Lamine River Basin and the Osage River Basin in Benton County. In Johnson County an acreage of native grassland in good condition is being managed as hayland.


MAP 18
PARK FACILITIES
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
INTERSTATE HIGHWAY
U. S. HIGHWAY
STATE HIGHWAY
BASIN BOUNDARY
LEGEND
STATE PARKS
STATE HIGHWAY PARKS
STATE FISH AND WILDLIFE AREAS
MUNICIPAL PARKS AND LAKES
CIVIC OR COMMUNITY PARKS
VAN METER STATE PARK
MALTA BEND
WAVERLY
MARSHALL
SLATER
COROER
ALMA
HIGGINSVILLE
ODESSA
CONCORDIA
SWEET SPRINGS
BLACKWATER
PILOT GROVE
HUGHESVILLE
LA MONTE
WARRENSBURG
KNOB NOSTER
HOLDEN
CHILHOWEE
SEDALIA
SMITHTON
COOPER
OTTERVILLE
MORGAN
SYRACUSE
MONITEAU
STOVER
BENTON
SALINE
PETTIS
LAFAYETTE
JOHNSON
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BLACKWATER
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SOURCE
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POLYCONIC PROJECTION
6-4-76
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Table 39.--Archeological Sites Listed on the National Register of Historic Places, Blackwater-Lamine River Basin, Missouri

Name and Location	Period	Description
Utz Archeological Site-Sec. 19, T.52N., R.21W. (23SA3)	Historic	National Historic Landmark
Plattner Archeological Site-Sec. 18, T.51N., R.22W. (23SA3)	Historic	Village
The Old Fort-Sec. 24, T.52N., R.22W. (23SA104)	Historic	Village
Gumbo Point Archeological Site-Sec. 11-12, T.51N., R.23W. (23SA4)	Historic	Village
The Imhoff Archeological Site-Sec. 7, T.48N., R.18W. (23CP7)	Woodland	Village
Mellor Village & Mounds Archeological District-Sec. 26-27, T49N., R18W. (23CP1, 23CP5, 23CP12)	Woodland	Village and Mounds
The Fisher-Gabbert Archeological Site-Sec. 3-4. T.52N., R.21W. (23SA128)	Woodland	Hopewell Village

Table 40.--Historic Sites and Buildings Inventory, Blackwater-Lamine River Basin, Missouri

Name and Location	Date	Description
SALINE COUNTY		
Baltimore-Thomas House; Grand Pass Area	1857	2-story, 9-room brick, Cherry & Walnut woodwork on lower story
Callaway-Hall, Thomas, House Waverly Area	1845	Brick, 2-stories, 8-rooms
First Presbyterian Church (Rock Church); Marshall 212 E. North St.	1871	Solid cut stone; Gothic style; stained glass windows; oldest church building in Marshall
Hardeman, John, House; Marshall ¼ miles south of Hardeman Store	1844	2-story frame with 2-story, 4 columned front portico - 8 fireplaces. 1st floor porch added along east and part of south side

Table 40.--Historic Sites and Buildings Inventory, Blackwater-Lamine River Basin, Missouri (continued)

Name and Location	Date	Description
SALINE COUNTY continued		
Mt. Olive Presbyterian Church and Cemetery; Marshall area 6 miles south	1853	Frame, present structure 1904
Murrel, George, House; Napton Area 1¼ miles south of Napton, 1/3 mile west of Jct. Rt. E to Rt. H on unmarked Road	1852	2-story, 9-room, T-shaped; frame Greek-Revival Style, 2-story front portico supported by columns
Callaway House - Hall, Thomas; Highway 240 midway between Grand Pass and Waverly	Ca. 1845	Brick structure - 2-stories, 8-rooms with an adjoining kitchen
Notley-Thomas House; 3 miles east of Waverly	1857	Large red brick, Greek Revival, 5-rooms down, 4-rooms up, 9 fireplaces.
Union Baptist; 6 miles west of Marshall on Hwy. 65, then 2 miles north	1860	Frame with basement
House; Lexington Ave. Sweet Springs		Brick
Smith Chapel Methodist Church; Napton		
Spring Park Home; Blackwater		
Wayman Chapel; 8 miles north from Marshall	1870	1-room frame
JOHNSON COUNTY		
Anderson House; Warrensburg	1866	Classic Revival
Crockrell House; Warrensburg		
Davis Grocery Store; Warrensburg	1846	Victorian
Elm Spring Church; Elm	1860's	Deserted; frame
Johnson County Courthouse; Warrensburg NRHP*	1896	Romanesque, constructed of Warrensburg sandstone, 2-stories with basement

* Listed in the National Register of Historic Places

Table 40.--Historic Sites and Buildings Inventory, Blackwater-Lamine River Basin, Missouri (continued)

Name and Location	Date	Description
JOHNSON COUNTY continued		
Old Johnson County Courthouse; Warrensburg	1838-41	Federal style, 2-story brick stuccoed
Music House; Knob Noster	1863	Brick
Negro School Building; Montserrat	1870's	1-room, frame
Old Post Office; Montserrat	1870's	2-story, brick
Menlo Park (President's House; Central Missouri State University); Warrensburg	1866	Brick
Thompson-Warnekl House; Knob Noster	1846	First post office, now private residence
LAFAYETTE COUNTY		
St. Thomas Presbyterian Church; Waverly	1844	Brick
Thomas House; Waverly	1818	Original log house
United Methodist Church; Waverly	1857	Brick
Warren-Gordon House; Waverly	1857	Brick, 2-stories with porch
Christian Church; Waverly	1859	Red brick; General Sterling Price occupied this church during the Civil War. Also used as a hospital
Combination of Lutheran School and Church; East Main, Corder	1890	1-room structure used as a church and church school by Lutherans at Corder
Company House (Coal Miner); Corder	1885	The only known company miners house left from the coal boom town of Corder
Callaway House; Waverly	1860's	1-story, frame
Klienschmidt Building; Corder	1900	One of the remaining original structures in Corder
Masonic Temple; Waverly	1870	Brick construction. Formerly a Baptist Church

Table 41.--Known Unique Scenic and Natural Areas, Blackwater-Lamine River Basin, Missouri

Description	Location
1- Scenic Rock overhang on Haw Creek	Morgan-Benton County line
2- Heron Rookery above Potter Ford on Flat Creek	Morgan County
3- Scenic Bluff on Flat Creek locally called Swack-Lammar hole	Morgan County
4- Bluff and Rock overhang on Haw Creek	Morgan County
5- Cedar Glade on Richland Creek	Morgan County
6- Cedar Glade Bluff on Lower Muddy Creek	Pettis County
7- Glade Bluff on Muddy Creek	Pettis County
8- Elk Lick Spring, Heath Creek	Saline County
9- Sweet Spring near Sweet Springs on Blackwater River	Saline County
10- Blue Lick Spring is a saline spring on Lower Blackwater drainage. Saline Springs have associated flora and fauna that is unique	Saline County

11. Environmental Corridors

Generally, an environmental corridor is identifiable because these resources are or were water related at some time. Therefore, watercourses, flood plains, steep slopes, poorly drained soils, wetlands, aquifer outcrops, important wildlife habitat, historic sites, and areas of scenic beauty can be combined into areas having identifiable boundaries.

These corridors were determined from the streams designated by the Missouri Department of Conservation for fishing purposes. These streams included wadeable, floatable, and motorable streams or portions of streams. The area of each corridor includes the entire flood plain and the facing slopes to the top of the bordering hills (Map 19). These exterior boundaries comprises a substantial area within each subbasin. In the Blackwater Subbasin the corridor acreage is 216,444 acres or 23 percent of the total subbasin area (Table 42). In the Lamine Subbasin, the 235,555 acres of corridor represents 35 percent of the total subbasin acreage. Of the basin's 526 stream miles within the corridors, 322 miles or 61 percent occur in the Lamine Subbasin while 204 miles are located in the Blackwater Subbasin.

EXISTING PROJECTS AND PROGRAMS

Federal and state programs that are important to water and related land resources are briefly discussed in this section. This discussion provides an insight into past and potential use of programs in developing the basin resources.

1. U.S.D.A. Programs

a. The Soil and Water Conservation Act. (Public Law 46, 74th Congress 1935).

Table 42.--Environmental Corridor Land Use, Blackwater-Lamine River Basin, Missouri

Description	Unit	Blackwater Subbasin	Lamine Subbasin	Total Basin
Subbasin area	Acres	935,826	676,300	1,612,126
Corridor area	Acres	216,444	235,555	451,999
Corridor streams	Miles	204	322	526
Corridor land use:				
Forest	Acres	32,320	67,440	97,760
	Percent	15	29	22
Urban	Acres	2,640	40	2,680
	Percent	1.2	0.02	0.6
Crop, pasture and other	Acres	181,484	168,075	349,559
	Percent	84	71	77

This act is administered by the Soil Conservation Service. The objectives of this act are to plan and carry out a national program of soil and water conservation through conservation districts, it helps communities solve resource problems that are restricting their growth. Assistance is provided by advisory services and counseling. This is usually made available to owners and operators of private lands; units of local, county, and state government; zoning and planning bodies, etc. Technical assistance to individuals in planning and applying soil and water conservation practices plus consultive assistance to units of government is also furnished.

b. The Watershed Protection and Flood Prevention Act. (Public Law 566, 83d Congress, 68 Stat. 666 as amended).

This act is administered by the Soil Conservation Service. The objectives are to provide technical and financial assistance in planning and carrying out works of improvement to protect, develop, and utilize the land and water resources in small watersheds. The U.S. Forest Service provides technical assistance on forest land in cooperation with Missouri Department of Conservation, Division of Forestry. Assistance is provided in planning, designing, and installing watershed works of improvement; in sharing costs of flood prevention, irrigation, drainage, sedimentation and erosion control; and in fish and wildlife developments and public recreation. Long term credit is extended to help local interests with their share of the costs. Two watershed applications have been received to date - South Fork of Blackwater River and North Fork-Honey Creek. Planning on the South Fork of Blackwater River was originally completed in 1962, and a revised plan was completed in 1974. North Fork-Honey Creek Watershed was authorized for planning in December, 1967, and planning on this watershed was terminated in 1975.

c. The Resource Conservation and Development Act. (Public Law 703, 87th Congress 1962).

This act is administered by the Soil Conservation Service. The U.S. Forest Service provides assistance on forest lands in cooperation with Missouri Department of Conservation. The objectives are to assist local people to initiate and sponsor programs for developing and carrying out

long-range plans of resource conservation and development, develop a dynamic rural community with a satisfactory level of income and with pleasing environment through planned improvement of resources, and create a favorable investment climate attractive to private capital.

d. The Agricultural Conservation Act. (Public Law 46, 74th Congress 1935).

The Agriculture Conservation Program of the act is administered by the Agriculture Stabilization and Conservation Service. This program cost shares in the application of certain soil and water conservation measures with land users.

e. The Consolidated Farmers Home Administration Act of 1961. (Public Law 128, 87th Congress 1942).

This act is administered by the Farm and Home Administration. It provides loans accompanied by technical advice in farm and financial management to help farm families make needed adjustments in their operations; operate, buy, and develop family farms; finance new income-producing enterprises such as forestry and recreation, and continue operations after being damaged by floods, droughts, freezes, and other natural disasters.

f. The Federal Extension Programs (Smith Lever Act as amended, 1914).

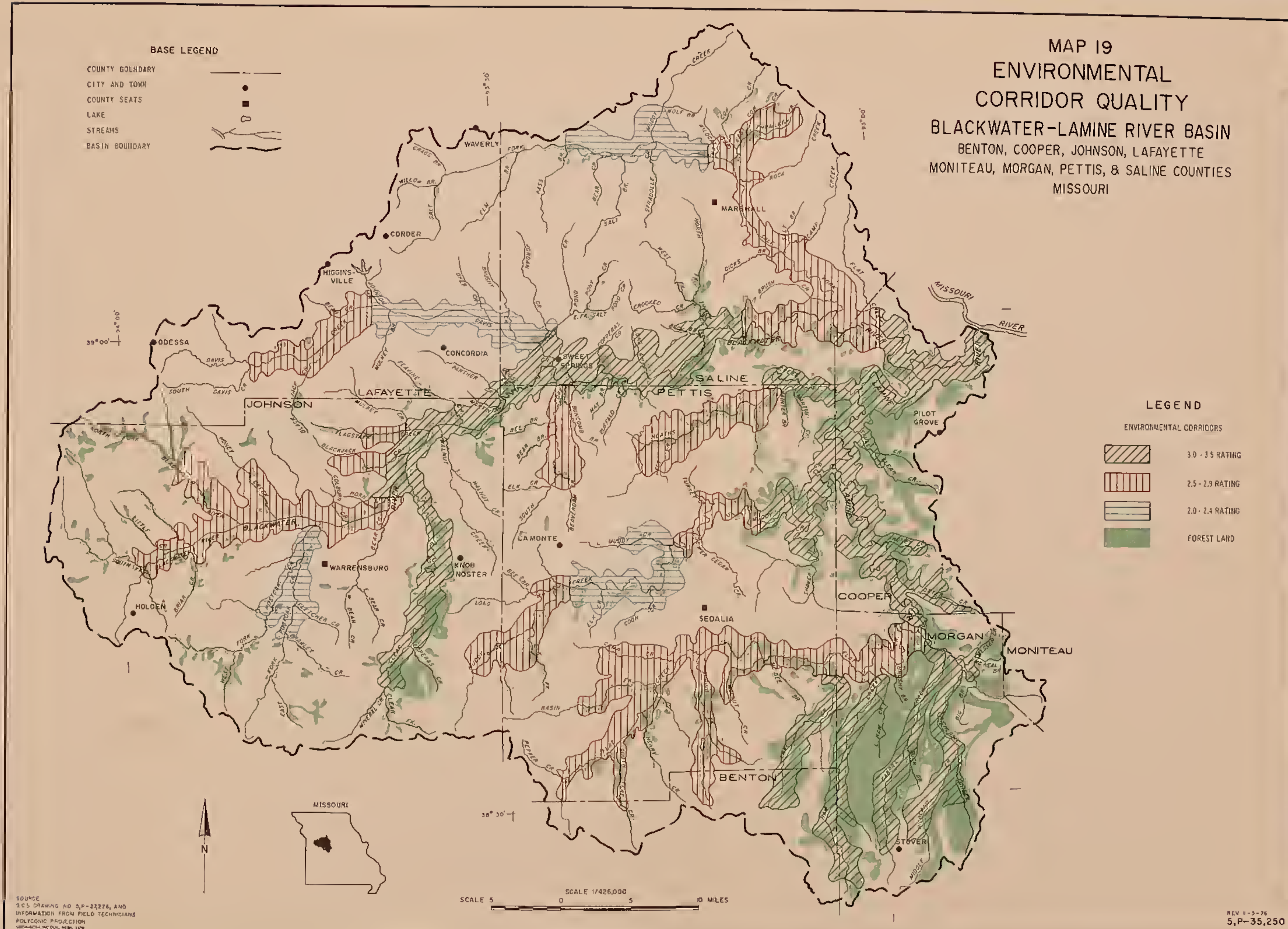
These programs are administered by the Federal Extension Service. Federal, state and county government share in financing, planning, and carrying out extension educational programs. The Extension Service acts as the education agency of the U.S. Department of Agriculture and the Land Grant Universities. Extension specialists work with other agencies to provide local people information relating to soil and water conservation programs.

g. State and Private Forestry Cooperation (Forest Pest Control Act 1947) (Clark-McNary Act 1924) (Cooperative Forest Management Act 1950) (Appropriation Act-GFA) (Agriculture Act 1956) (Agriculture and Consumer Protection Appropriation Act of 1975 FIP ACP).

These programs are administered by the Forest Service. They provide the assistance, normally through State Forestry agencies, for protection, management, and development of state, local, and privately-owned forest land and processors of forest products. Assistance is provided to improve fire control and protection of forests from insects and diseases; in land use planing, to develop multiple use management so as to obtain the maximum use potential from forest resources; and to improve practices in harvesting and marketing of forest products.

h. Rural Electrification Administration (Rural Electrification Act of 1936, as amended; Public Law 74-605).

Electricity is provided to rural areas through 3 electric cooperatives. In 1974, 4,200 miles of line were energized, which served 12,200 customers an average of 3,100 kilowatt - hours per month for a total consumption of over 37 million kilowatt - hours. The following cooperatives serve the basin:


MAP 19
ENVIRONMENTAL
CORRIDOR QUALITY
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
BASIN BOUNDARY
LEGEND
ENVIRONMENTAL CORRIDORS
3.0 - 3.5 RATING
2.5 - 2.9 RATING
2.0 - 2.4 RATING
FOREST LAND
WAVERLY
CORDER
HIGGINSVILLE
ODESSA
CONCORDIA
SWEET SPRINGS
MARSHALL
PILOT GROVE
LAMONTE
KNOB NOSTER
WARRENSBURG
HOLDEN
SEDALIA
STOVER
JOHNSON
LAFAYETTE
SALINE
PETTIS
COOPER
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INFORMATION FROM FIELD TECHNICIANS
POLYCONIC PROJECTION
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5,P-35,250

Central Missouri Electric Cooperative, Inc., Sedalia; Co-Mo Electric Cooperative, Inc., Tipton; and West Central Electric Cooperative, Inc., Higginsville.

2. Other Federal Programs and Projects

a. National Flood Insurance Act (As amended by Public Law 93-234 Enacted 12-31-73).

This act is administered by the Department of Housing and Urban Development. The act makes flood insurance available nationwide to eligible cities, towns, and communities at subsidized rates. In order to be declared eligible for this insurance, local and state governments must adopt and enforce flood plain zoning and land use regulations.

b. U.S. Corps of Engineers, Kansas City District.

This agency has completed an earlier study of this basin that resulted in a report dated March 1960. The report was prepared in response to a resolution by the Committee on Flood Control, U.S. House of Representatives, adopted September 18, 1944, 73d Congress.

This report mentions that the Missouri 308 Report was submitted to the 1933 Congress and published as House Document No. 238. The 308 Report recognizes the local flood problems of the Lamine and Blackwater Rivers. The proposed project-consisting of flood control structures, channel improvement and levees-had an unfavorable benefit-cost ratio.

A study of Flat Creek, a tributary to Lamine River in the vicinity of Sedalia, Missouri, was authorized by a resolution adopted by the Committee on Public Works, U.S. House of Representatives on October 5, 1966. The results of this study were presented at a public meeting in June 1972 at Sedalia. Since the benefits were less than the costs, no project was recommended.

c. Public Works and Economic Act. (Public Law 89-136).

The Ozarks Economics Development Region was established to plan for and assist in the initiation of sustained economic development. The designated area includes all of Missouri and parts of Arkansas, Kansas and Oklahoma.

3. State and Local Programs and Projects

a. Drainage Districts

Three drainage districts have been organized in the basin. The Blackwater Drainage District No. 1 was organized under Circuit Court Law, November 23, 1909. The project was completed March 1, 1913. This district, located totally in Johnson County, has a 23,084 acre drainage area. Included in the project was 27 miles of main ditch on the Blackwater River and 25 miles of laterals. The main ditch of Blackwater extended from 10 miles west of Warrensburg to two miles upstream from the Johnson-Pettis County line. Some of the larger tributaries excavated include North Fork Creek, 2.8 miles; Post Oak Creek, 4.25 miles; Bear Creek, Clear Fork and Black Jack Creek each 0.5 miles; Flagstaff Creek, 1 mile; Walnut Creek, 2.7 miles; and Peavine Creek,

1.8 miles.

Two drainage districts were organized on Davis Creek. Both are in Lafayette County. Davis Creek Drainage District No. 1 organized June 6, 1907, extends from the Lafayette-Saline County line upstream to Johnson Creek about 1 1/2 miles east of Aullville. This includes 9.6 miles of channel. Davis Creek Drainage District No. 2, organized August 2, 1909, extends from Johnson Creek upstream 8.6 miles. Included in this drainage district is a total of 2.75 miles of laterals on Black Jack Creek and unnamed tributaries. These drainage districts were formed to provide a channel for drainage outlets and also to reduce flood flows.

b. Soil and Water Conservation Districts

A Soil and Water Conservation District is a legal subdivision of State Government which is directed by a Board of Supervisors who are elected by the people of the district. It operates under rules of the state's Enabling Act which is administered by the Missouri Soil and Water District's Commission. The supervisors are responsible for directing an action program to implement soil and water conservation practices within the district.

All the counties in the basin except Morgan County have organized Soil and Water Conservation Districts. Each district has developed a long-range conservation program. The Board of Supervisors prepares an annual calender of work specifying the annual objectives for the coming year.

The districts have requested technical assistance from the Soil Conservation Service through the provisions of the Soil Conservation Act (Public Law 46, 74th Congress, 1935). This assistance is made available to the landowners who are co-operators, to plan and use their land within its capabilities. Soil surveys and interpretations, finding and improving plant materials for conservation uses, and providing agronomic and engineering field assistance in applying conservation measures are technical assistance provided.

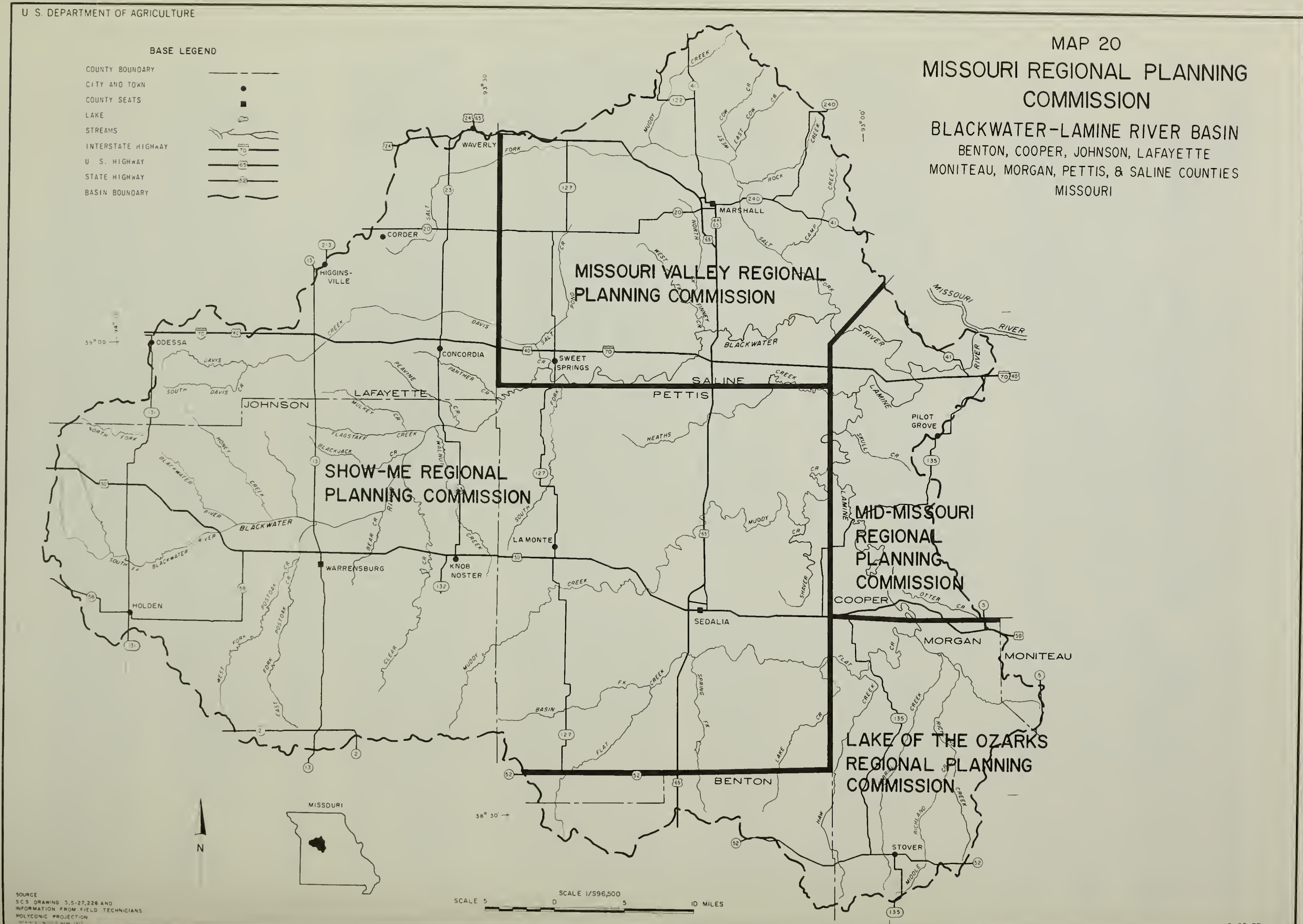
Subdistricts of a soil and water conservation district may be formed for the purpose of carrying out watershed protection and flood prevention programs, for the prevention of floodwater and sediment damage, for furthering the conservation development, utilization and disposal of water, for increasing recreation and industrial development and for the development of agricultural water management, irrigation and drainage.

c. The State and Regional Planning and Community Development Act of 1966.

This act was enacted by the 73d General Assembly of the State of Missouri. The state is divided into 20 regional planning commissions. The basin includes parts of four regional planning commissions; Show-Me, Missouri Valley, Mid-Missouri and Lake of the Ozarks (Map 20).

The Regional Planning Commissions have a wide range of duties and responsibilities; among them is making and adapting a comprehensive plan for the development of the region. The comprehensive plan is made with the general purpose of guiding and accomplishing a coordinated, adjusted, and harmonious

development of the region. The plan will, in accordance with existing and future needs, best promote public health, safety, morals, order, convenience, prosperity or the general welfare, as well as efficiency and economy, in the progress of development. These plans have been developed and printed for use of local governing bodies.


U. S. DEPARTMENT OF AGRICULTURE
MAP 20
MISSOURI REGIONAL PLANNING COMMISSION
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
INTERSTATE HIGHWAY
U. S. HIGHWAY
STATE HIGHWAY
BASIN BOUNDARY
MISSOURI VALLEY REGIONAL PLANNING COMMISSION
SHOW-ME REGIONAL PLANNING COMMISSION
MID-MISSOURI REGIONAL PLANNING COMMISSION
LAKE OF THE OZARKS REGIONAL PLANNING COMMISSION
SALINE
PETTIS
LAFAYETTE
JOHNSON
COOPER
MORGAN
MONITEAU
BENTON
WAVERLY
MARSHALL
CORDER
HIGGINS-VILLE
ODESSA
CONCORDIA
SWEET SPRINGS
PILOT GROVE
LAMONTE
KNOB NOSTER
WARRENSBURG
HOLDEN
SEDALIA
STOVER
MISSOURI RIVER
BLACKWATER
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INFORMATION FROM FIELD TECHNICIANS
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CHAPTER III

Present and Future Problems, Needs, and Capabilities

PRESENT AND FUTURE PROBLEMS, NEEDS, AND CAPABILITIES

This chapter discusses the problems and needs of water, related land for production of food and fiber and the development of water resources to meet the needs for water supply, fish and wildlife, and outdoor recreation.

An evaluation of resource problems and needs are essential to developing a basin plan. The concerns of the local people were expressed at meetings held within the basin. State agencies also made contributions. These concerns were investigated and stated in the form of problems. In addition, present and future needs for goods and services determine needs for resource development. Where applicable, basin limitations for resource development are stated.

EROSION AND SEDIMENT

Soil erosion, sediment deposition and flooding are all closely interrelated to the volume and intensity of rainfall. Erosion is most severe when barren fields and intensive rainfalls coincide. Displaced soil particles are transported varying distances. Some particles are deposited only a short distance from their source while others are deposited in small streams. The finest particles may stay suspended traveling miles downstream. Many floods cause accelerated channel erosion, flood plain scour and sediment deposition.

Gross erosion amounts to over 21,000,000 tons of displaced soil annually (Table 43). About one-fourth of this displaced soil or, 5,500,000 tons arrive in suspension at the mouth of the basin and discharge into the Missouri River.

Table 43.--Annual Gross Erosion and Sediment Yield by Source, Blackwater-Lamine River Basin, Missouri

Source	Subbasin		Total
	Blackwater	Lamine	Basin
	- - - - - - - thousand tons - - - - - - - - - - - -		
Gross Erosion			
Sheet	9,141	6,582	15,723
Gully	1,522	954	2,476
Other	1,907	1,235	3,142
Total	12,570	8,771	21,341
Tons per acre	12.7	12.4	12.5
Sediment Yield 1/			
Sheet	503	428	931
Gully	1,141	715	1,856
Other	1,647	1,025	2,672
Total	3,291	2,168	5,459

1/ At mouth of subbasin

1. Sheet Erosion

The major conservation problem in upland agricultural areas is sheet erosion. It not only reduces the productivity of the area through loss of top soil and plant nutrients but also is the major cause of pollutants entering streams and reservoirs. Sheet erosion displaces over 15,000,000 tons of soil annually. Land use, land management, rainfall, slope and soil type are the major factors determining rates of erosion. Soil type and slope are the inherent land factors that determine the potential erodability of a soil but land use and management are the variables by which erosion can be controlled.

Most erosion occurs on tilled cropland. Although only a third of the upland area is used for tilled crops, 90 percent of all erosion occurs on cropland (Table 44). Erosion on forested and pastureland is small when compared to tilled cropland. Only 2 percent of the erosion on inventory upland occurs on pasture and hayland which accounts for 50 percent of the upland use. Only 8 percent of the erosion occurs on forest land which accounts for 17 percent of the upland use. About 10 percent of the upland in tilled crops is suitably managed and adequately treated for erosion control. This land has an annual rate of erosion of less than 3 tons per acre. However, 23 percent of the total upland in tilled crops is being tilled without adequate treatment. This inadequately treated land contributes 87 percent of the upland erosion.

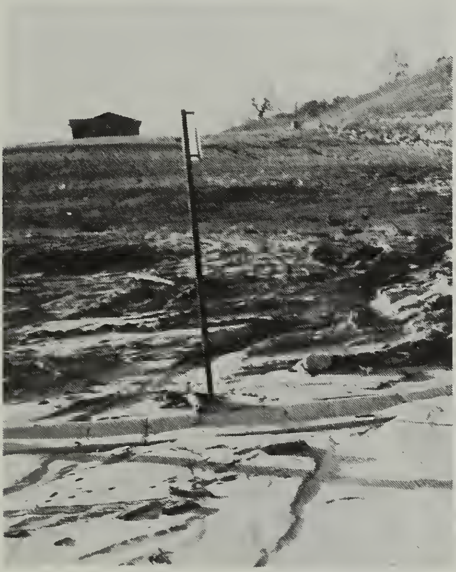
Table 44.--Percent of Erosion by Upland Land Use, Blackwater-Lamine River Basin, Missouri

	Percent of inventory upland acres	Percent of erosion
Forest land	17	8
Pasture and Hay	50	2
Cropland	33	90

Although soil productivity group SPG U_3 is inherently the most susceptible it has only 9 percent of the erosion. Tillage is not economically feasible and it is primarily in pasture and forest. For SPG U_2, 14 percent of the land being tilled without adequate treatment is the source of 62 percent of the erosion.

The type of treatment needed to reduce erosion varies by land use and soil group (Figure 22). The portion of land adequately treated varies from almost zero for SPG U_3 in the Lamine Subbasin to 40 percent in SPG U_2 in the Blackwater Subbasin. The major types of treatment needed to control erosion on most cropland are contouring, conservation tillage, crop rotation, stripcropping, terraces, waterways, and diversions. For SPG U_3 the primary need is to change the land use from tilled crops to pasture or forest.

The portion of pastureland adequately treated varies from almost zero on SPG U_3 in the Lamine Subbasin to 42 percent in SPG U_1 in the Blackwater Subbasin (Figure 23). The primary types of treatment needed to reduce erosion on pastureland are protection from overgrazing and improved plant cover.



Sheet erosion and sediment results when the soil is left unprotected.

Figure 22.--Tilled Cropland Treatment Needs by Soil Productivity Group and Subbasin, Blackwater-Lamine River Basin, Missouri

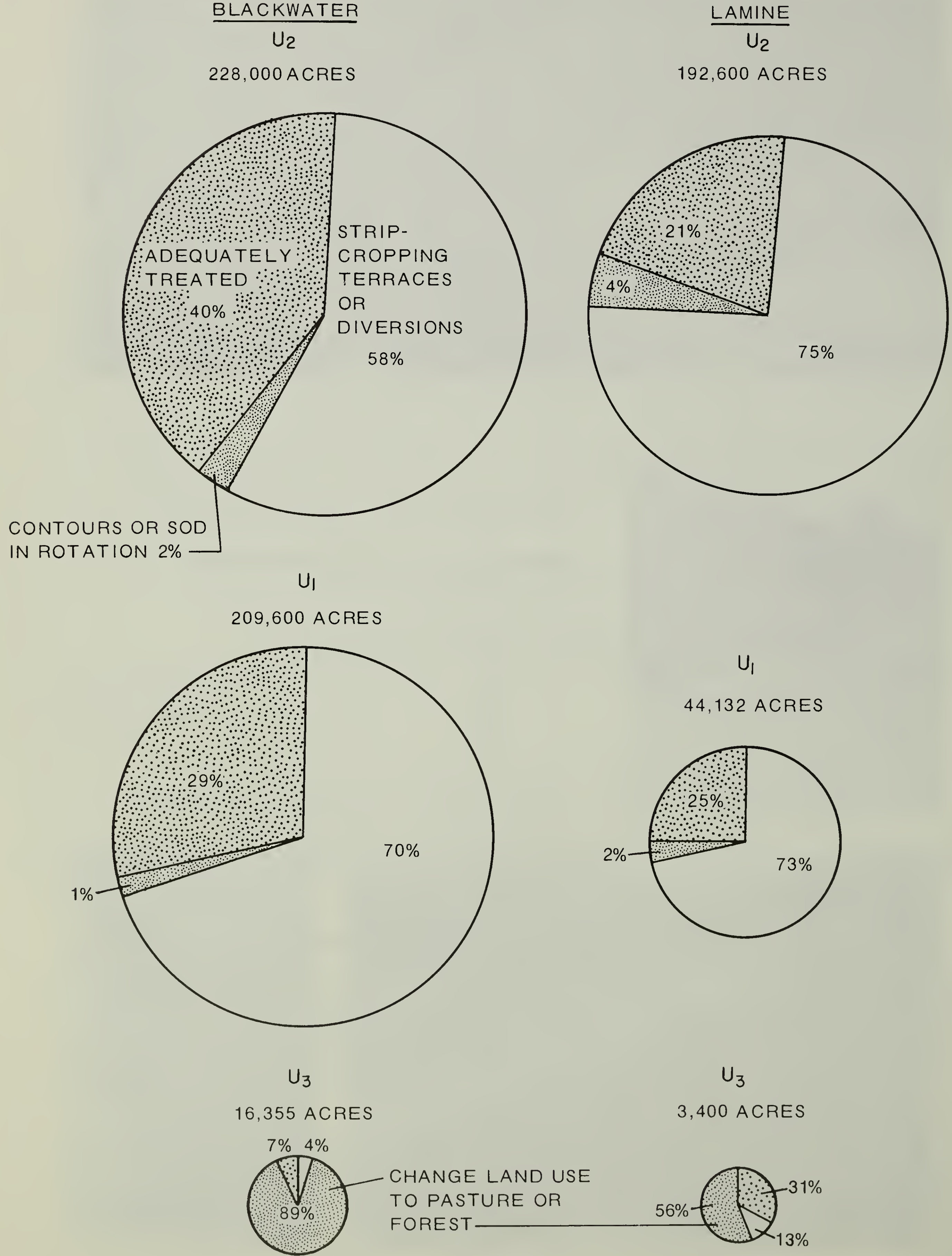
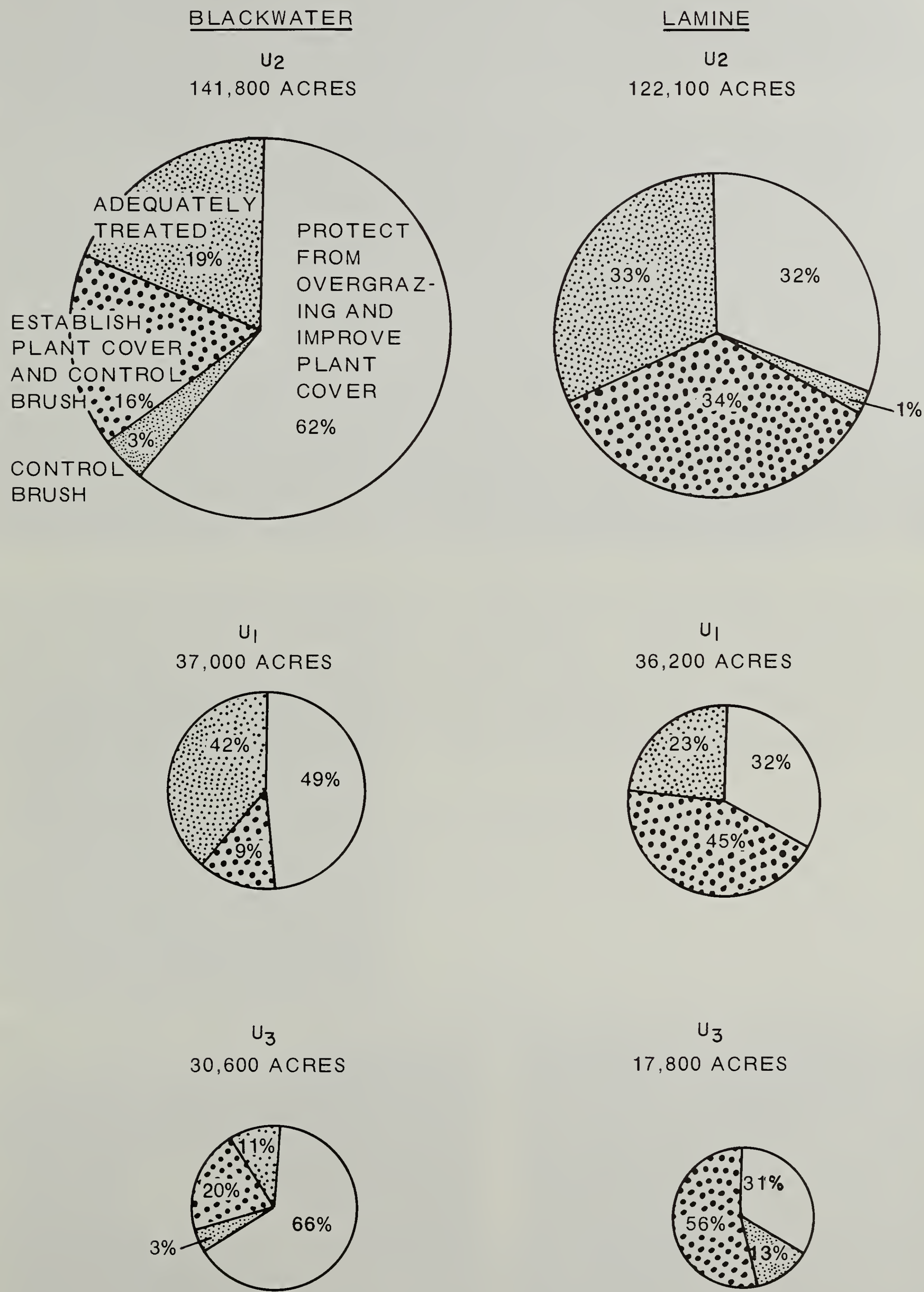


Figure 23.--Pasture and Hay Treatment Needs by Soil Productivity Group and Subbasin, Blackwater-Lamine River Basin, Missouri



2. Gully Erosion

Gully and streambank erosion occur in all parts of the basin. Gullies are most numerous in areas that are subject to high sheet erosion. The deeper gullies are in the Upper Blackwater River, Post Oak Creek, Davis Creek, and Salt Fork Creek. Shallower gullies, of 3 to 5 feet deep, are located throughout the basin. Damages that result from gully erosion include destruction of land for productive use by the creation of a void and depreciation of adjacent land. In the Lamine River Subbasin an estimated 954,000 tons of soil erodes annually. Gullies are created too large to be crossed by farm machinery. The result is 960 acres of voided and depreciated land annually. In the Blackwater River Subbasin an estimated 1,522,000 tons of soil erodes annually and voids or depreciates 2,115 acres of land. The present combined soil loss is estimated to be 2,476,000 tons.

The type of treatment needed to reduce gully erosion depends on the depth of gully and its drainage area. Shallow gullies having small drainages can generally be corrected by shaping and planting. Structural measures may be required to control larger gullies with drainage areas of 50 to 100 acres. Structural measures need to be located so as to control the head cut of the gully. Vegetation and structural measure treatment of gullies can vastly reduce this type of erosion.

3. Other Erosion

The major remaining erosion types are flood plain scour, roadside, and accelerated channel erosion. Flood plain scour occurs during flood flows along streams in the basin. This type of erosion makes up about 10 percent of the total erosion in the basin. Some erosion occurs on all flood plain land during flood flows. Each year an estimated 10,120 acres of Lamine River and 2,670 acres of Blackwater River flood plain land have erosion severe enough to reduce crop production.

Erosion occurs on dirt and gravel road surfaces and in adjacent road ditches. The erosion in road ditches is usually caused by concentrated water. An estimated 270 acres of gullies are created each year in road ditches. The total annual erosion from roads and ditches is about 1,185,000 tons of soil.

Accelerated channel erosion occurs on 18 miles of Davis Creek and 27 miles of Blackwater River where channels were straightened in the early 1900's. Channel straightening increased velocities causing channel bottoms and banks to erode. Channel degradation migrated upstream from main channels into tributary streams. The soil erosion from channels is estimated at 444,000 tons annually. About 17 acres along streams are lost each year to erosion.

4. Sediment

Flooding and sediment deposition are affected by high storm runoff and channel filling. Erosion is the major factor determining the amount of sediment. Erosion from gullies, roadbanks and urban development contribute large volumes of sediment in local areas. Sheet erosion from agricultural land yields sediment that is more evenly distributed.

Other sediment comes from the erosion of gullies, roadsides and streambanks.

Total sediment includes suspended sediment, bedload, and wash load. Sediment is deposited along water courses in the flood plain, in stream bottoms and on streambanks. The remaining sediment leaves the basin and enters the Missouri River (Table 45). It adds to concerns for water quality and maintaining navigation flows on the Missouri River.

Table 45.--Sediment Delivered Annually To The Outlet of Basin, Blackwater-Lamine River Basin, Missouri

	Present condition	Projected year 2000
	acre feet	
Lamine River	1205	1041
Blackwater River	1828	1485
Total Basin	3033	2526

Sediment carries with it potential pollutants that may be detrimental to the health of animals and plants. Suspended sediment must be removed from surface water that is used for municipal and industrial purpose. When suspended in reservoirs it decreases the value for aesthetic and recreational use.

A suspended sediment sampling station, maintained by the Corps of Engineers, is located on the Blackwater River at the Blue Lick Stream gage. The period of record, however, is only three years (Table 46).

Table 46.--Suspended Sediment at the Blue Lick Stream Gage, Blackwater-Lamine River Basin, Missouri

Year	Volume of water	Suspended sediment	
	acre feet	--tons--	--tons/acre feet
1971	278,000	301,000	1.08
1972	248,081	407,185	1.64
1973	1,103,408	1,230,282	1.12

Erosion and sediment yields have increased as woodlands on private land have been converted to corpland. Sediment loads in streams increase as water velocities increase. The velocities increase as depth of flooding increases.

The major sediment problem in the Lamine River Subbasin occurs in the southeastern reaches where streambeds are a source of coarse sands and gravels. Floods deposit these coarse materials on approximately 1,700 flood plain acres annually. Scour damages occur annually on nearly all of the flood plain.

The Blackwater River Subbasin has a different problem with sediment deposits. Flood plain scour damages can be measured in terms of reduced productivity on 2,670 acres. Large volumes of sediment from flood plain scour; upstream channel, gully and sheet erosion are deposited on the flood plain. An estimated 2,520 acres of flood plain lands along the Blackwater River and its tributaries are damaged annually by sediment deposits.

Records show that the Blackwater River Channel bottom at the Blue Lick Stream gage, just upstream from U.S. Highway 65 south of Marshall, Missouri, has raised 6 feet in elevation since 1922. The build-up of sediment on Lower Davis Creek and Blackwater River near Sweet Springs, ranges from 10 to 18 feet.

These sediment deposits were derived from fertile top soil as well as gully and channel erosion. On the Blackwater River and its tributaries much of the deposited sediment is more fertile and better suited to crops than the soil it covered. The risk of sediment build-up is from swamping and internal soil drainage problems. Sediment also accumulates as natural levees impeding drainage into the stream. Swamping damages occur on 110 acres in the Blackwater Subbasin and 570 acres in the Lamine Subbasin.

FOREST LANDS

The constant clearing of forest land for other uses threatens the existing forest resources. Overgrazing, disease, fires and lack of reforestation and timber improvement are also problems that reduce the marketable forest products and lower forest land values.

1. Forest Land Base

Based on past trends, an anticipated 173,000 acres, about 58 percent, of forest land will be lost within the basin by the year 2020 (Table 47). Losses will occur to both the upland and bottom land hardwood stands. Most of this land use change will result from conversion of forest land to cropland and pastureland. The remainder will be lost to transportation, utility rights-of-way, urban-surburban-vacation home-industrial expansion, and water developments.

Table 47.--Present and Projected Forest Land, Blackwater-Lamine River Basin, Missouri

Subbasin	year			
	1970 1/	1980	2000	2020
	thousands of acres			
Blackwater	141	118	97	74
Lamine	157	144	123	51
Total	298	262	220	125

1/ Conservation Needs Inventory, - USDA, Missouri, 1967

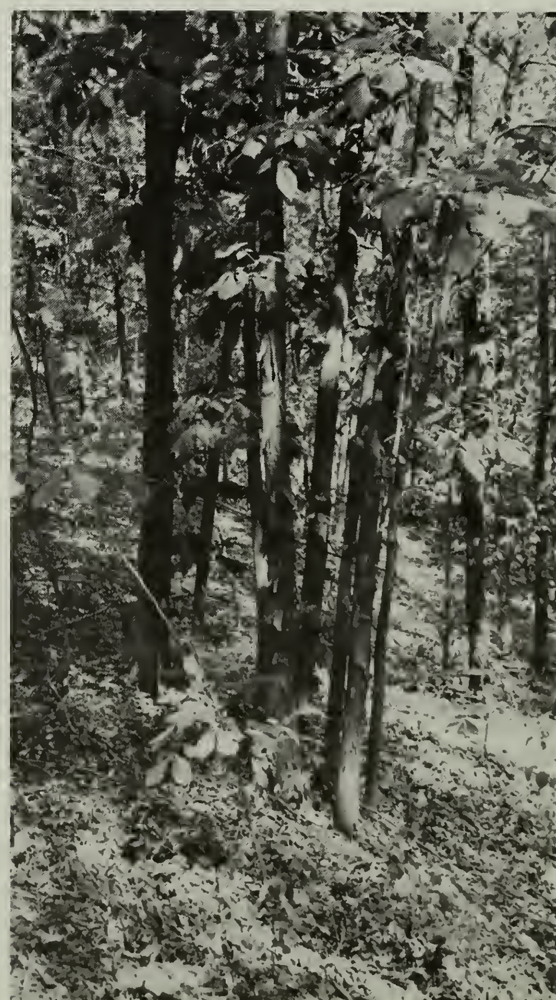
Within the total forest land base, commercial forest land--land capable, suitable, and available for producing commercial timber crops--will be changed to non-commercial forest land as a result of future recreation expansion and development. However, the magnitude of this change is not anticipated to be significant.

Reservoirs, while necessary for municipal-industrial water, recreation, and flood control, will contribute to the loss of forest land. In addition to these losses caused by inundation, project lands surrounding reservoirs will generally be managed for recreation and wildlife, excluding wood production. Once flood control becomes a reality, additional forest acreage may be

(Courtesy - Wooldridge - Missouri Department of Conservation)

Livestock exclusion and the improvement of timber stands are needed to provide more marketable forest products.

(Courtesy - Wooldridge - Missouri Department of Conservation)



converted to crop and pastureland in bottom land areas below the reservoir. In some projects, private lands adjacent to project lands are purchased for vacation home sites and subdivisions which reduces forest land acreage, reduces wildlife habitat, and effectively eliminates wood production uses of forest land. This loss of forest land could be replaced through forestation of other lands; however, it would require considerable time before these tracts would become productive.

2. Grazing

Approximately three-fourths of the forest land is grazed by domestic livestock. About 83 percent and 66 percent of the forested areas of the Lamine and the Blackwater Subbasins are grazed respectively.

Moderate to heavy grazing deteriorates forest wildlife habitat, causes losses in timber productivity, damages trees, and results in excessive erosion and sediment yield from forest land. In general, grazing of bottom land hardwood stands causes fewer problems than the same intensity of grazing in the upland stands--especially for erosion and sediment yield. In the Blackwater Subbasin, approximately two-thirds of the forest grazing occurs in the uplands. In the Lamine Subbasin, nearly 90 percent of the forest grazing occurs within the upland hardwood stands. Generally, forest does not provide good forage production. Most grazing on forest land is incidental browsing from adjacent unfenced pastures. During the hot summer months, adjacent forest land provides some shade for the browsers.

Some areas in the basin classified as forest land are utilized primarily for grazing. Scattered trees with a grass understory have been classified as forest land. To improve livestock forage, some landowners find it desirable to remove the remaining trees and manage the pasture intensively.

Where there is a minimum or better stocking level of desirable species and sizes, forest land should be managed for dispersed recreation, wildlife, watershed protection, and wood production. Management for these uses would require fencing of pastures; fire, insect, and disease protection; reforestation; timber stand improvement; and periodic harvesting of wood products on a sustained yield basis. Reforestation, timber stand improvement, forage improvement and grazing reduction are needed for better forest management (Table 48).

3. Wildlife

Wildlife use of forest land is one of the major multiple-users. Deer, turkey, quail, dove, wood duck, squirrel, rabbit, fox, and coyote use the forest land habitat for both food and cover. Also, furbearers including mink, muskrat, and raccoon utilize forest land along streams, rivers and lakes as part of their total habitat. Non-game species of birds and mammals also use the forest environment to varying degrees.

Because forest land is expected to decline in the basin; those species which require a forest habitat for food and cover may diminish.

Reforestation and grazing control over large areas will lessen the impacts of continued conversion to crop and pasture. Many soils are not

Table 48.--Forest Treatment Needs, Blackwater-Lamine River Basin, Missouri

Subbasin and county	Reforestation	Timber stand improvement	Forage improvement	Grazing reduction
	Treatment needs			
	- - - - - - - - - - - - -acres - - - - - - - - - - - - -			
Blackwater Subbasin				
Benton	0	0	0	0
Cooper	246	2,094	41	1,989
Johnson	211	40,776	480	23,533
Lafayette	394	16,866	717	13,556
Moniteau	0	0	0	0
Morgan	0	0	0	0
Pettis	45	7,620	390	6,105
Saline	604	22,461	2,142	24,632
TOTAL	1,500	89,817	3,770	69,815
Lamine Subbasin				
Benton	570	17,830	544	17,599
Cooper	1,824	12,404	300	14,728
Johnson	81	15,544	183	8,971
Lafayette	0	0	0	0
Moniteau	562	484	20	992
Morgan	15,732	21,455	2,177	34,113
Pettis	311	52,386	2,679	41,965
Saline	158	5,863	559	6,430
TOTAL	19,238	125,966	6,462	124,798
Basin				
Benton	570	17,830	544	17,599
Cooper	2,070	14,498	341	16,717
Johnson	292	56,330	663	32,504
Lafayette	394	16,866	717	13,556
Moniteau	562	484	20	982
Morgan	15,732	21,455	2,177	34,113
Pettis	356	60,006	3,069	48,070
Saline	762	28,324	2,701	31,062
TOTAL	20,738	215,793	10,232	194,603

Source: Conservation Needs Inventory, Missouri, USDA, 1970

capable of producing crops but are capable of growing permanent vegetation.

4. Recreation

The present and projected forest land acreage devoted to intensive recreation use in the basin is small. Developed recreation areas are subject to erosion, soil compaction, loss of understory plants, deterioration of overstory trees, and loss of good wildlife habitat. To control these problems there is a need for proper design and layout of recreational facilities, traffic control, adequate care, policing and maintenance of facilities, regulating the number of persons according to the carrying capacity, and using a rest-rotation method of management.

Problems also develop on forest land where recreation is dispersed. However, because the land and surroundings are used less intensively, none of the problems are comparable in magnitude to those occurring on developed sites.

5. Watershed Protection

A well managed block of forest land provides excellent watershed protection, and yields high quality water to adjacent streams and rivers. This water, in turn, enhances the fishery resource in terms of species quantity and quality.

Most of the forest land in the basin is in poor hydrologic condition primarily because of excessive grazing. Other causes include poor logging practices, poor road development and maintenance, intensive recreation use, poor utility right-of-way maintenance, and wildfires.

Forest land is eroding at a basin-wide rate of 0.5 tons per acre per year, while some feedlots are eroding in excess of 30 tons per acre per year.

The capability exists to solve most of the watershed protection problems associated with forest land by reducing livestock numbers, or eliminating grazing on specific areas; by improving logging practices, road and utility maintenance, and recreation management. Some areas require revegetation, rill and gully erosion control, or installation of additional culverts in dips, etc. on permanent roads.

6. Wood Production

The supply of growing tree stock at the present time exceeds present demand for wood products (Table 49). However, some species such as white oak, soft maple, and sycamore are being overcut. Also, white oak and black walnut in the larger, higher quality sizes are becoming rare. Most of the growing stock volume is coming from smaller, less desirable quality trees and from less desirable species. By the year 2020, demand for wood products grown in the basin will exceed the basin's supply by 3.8 million of cubic feet. The major reason for this change is that demand for pulpwood will increase nearly 13 times from 1970 to 2020, while growing stock volume available for cutting will increase about 2 1/2 times during the same time span.

Table 49.--Present and Projected Timber Products, 1/ Blackwater-Lamine River Basin, Missouri

Year	Demand				Supply
	Sawlogs	Pulpwood	Fuelwood	Total	
	- - - - - - - - - - -millions of cubic feet - - - - - - - - - - -				
1970	1.0	0.7	0.2	1.9	2.5
1980	2.0	2.8	0.2	5.0	4.4
2000	1.6	6.6	0.2	8.4	5.8
2020	0.6	9.0	0.2	9.8	6.0

1/ Missouri Forest Survey Data and OBE-ERS Projections.

The capability exists to alter the demand-supply projection in the near future by acceleration of the forest land treatment program. Reforestation, timber stand improvement, and grazing control would constitute the most important practices needed. Other practices would include insect and disease protection, fire control, and erosion control. Land use zoning, which would keep intact the forest land needed for projected demand, would also be of great value. Even under the best conditions during the 50-year span from 1970 to 2020, it is not likely that the supply of growing stock timber available for cutting will meet expected demands.

Certain bottom land areas having high flooding frequencies will not receive flood protection in the future, although land owners continue to grow row crops. Some of these areas are suited to growing cottonwood for pulpwood production. A number of existing cottonwood trees were checked for growth rates and were found to be growing fast. If planted to cottonwood, landowners could realize a profit from these bottom land areas that generally fail to yield a row crop.

Several landowners are establishing a walnut pasture crop for multicropping benefits on some of the better upland sites. Walnut seedlings are planted on a relatively wide spacing in conjunction with pasture or hayland. Under proper care, these fields produce walnuts and forage or hay after several years. Later, these areas could produce high value walnut logs as a third product off the same acreage. Wildlife would also benefit from the establishment of these plantations.

7. Wildfire

Fire is not considered a major problem to forest land. Part of the Lamine Subbasin is currently protected from wildfires by the Missouri Department of Conservation. The remainder of the basin receives limited protection from rural fire departments. The present fire protection program is adequate and should be continued.

Wildfires can kill timber and damage the boles of trees. This will cause rot, set the stage for insect attacks, cause erosion, kill wildlife, destroy wildlife habitat, and pollute air and water.

8. Insects and Disease

The variable oak leaf caterpillar periodically defoliates extensive hardwood areas. Severe infestations occurred over large areas of Missouri in 1970. Some damage was reported in the basin. While infestations usually subside before many trees are killed, heavy defoliation reduces tree growth and vigor. 1/ Chemical control of the insect has not been attempted on a large scale.

In recent years, the Dutch Elm disease has been the most important and damaging disease. American elms--both in the uplands and bottom lands--have died during this outbreak resulting in a large reduction of sawlog size trees.

1/ Insects and Diseases of Trees in the South, U.S.D.A., Forest Service, Atlanta, Georgia. 1972.

Control measures have been found but are uneconomical in large stands of timber.

Sycamore anthracnose has become quite widespread within the past several years. It generally causes temporary dieback of twigs, buds, shoots, and leaves when weather conditions are favorable in the spring for spreading the disease. Individual trees which have been more severely infected for the past 3 to 4 years because of adverse weather conditions, may suffer severe dieback and, in some cases, death. Control of this disease under forest conditions is not economically feasible. Where the disease is prevalent, other species should be favored during thinnings. A host of other insects and diseases affect trees within the basin but are of less significance.

9. Forest Treatment Needs

About 75 percent of the reforestation needs are in Morgan County. Johnson and Pettis Counties have about 55 percent of the total timber stand improvement program needs. Pettis County has about 25 percent of the grazing reduction needs.

FLOODING AND DRAINAGE

The problems on bottom land soils are complicated by practices of channelization and land use during the past 70 years. In many reaches of the Blackwater Subbasin flooding, sediment deposition and drainage are interrelated problems. As such, these problems not only limit agricultural production but relate to damages to roads, bridges and other flood plain structures. This inter-relationship by reaches is an important part of the following discussion.

Flooding and drainage are major water problems reducing agricultural productions on bottom land soils. Seventy-three percent of flood plain soils have one or both of these problems (Table 50). Although the Blackwater Subbasin has more bottom land than the Lamine, 54 percent of the Blackwater bottom land soils and 53 percent of the Lamine bottom land soils have significant flooding problems. Drainage problems are found on 50 percent of the Blackwater Subbasin and 47 percent of the Lamine Subbasin bottom lands soils.

Table 50.--Flooding and Drainage Problems, Blackwater-Lamine River Basin, Missouri, 1970

Problem	Blackwater subbasin		Lamine subbasin		Total Basin	
	Acres 1000	Percent	Acres 1000	Percent	Acres 1000	Percent
Flooding only	36.9	24	25.1	24	62.0	24
Flooding and drainage	46.3	30	29.6	29	75.9	29
Drainage only	32.0	20	19.0	18	71.0	20
Total flooding	83.2	54	54.7	53	137.9	53
Total drainage	78.3	50	48.6	47	126.9	49
No problems	39.8	26	29.4	29	69.2	27
Total bottom land	155.0	100	103.1	100	258.1	100

Source: 1967 Conservation Needs

No significant correlation was found between severity of flooding and intensity of land use. Apparently a more important factor in determining bottom land use, is the individual farmer. Most farmers apparently plan land use by fields rather than problem areas.

In the basin, 67 percent of the cropland, hayland and pastureland on bottom land soils have flooding or drainage problems (Figure 24). In contrast, 90 percent of the forest land floods or has drainage problems.

The present and future needs for flood prevention and sediment control are based on the current average annual damages for 1970 and their projection for the bench mark years of 1980, 2000 and 2020. Floodwater damages are expected to increase from $2,938,600 in 1970 to $4,892,500 by year 2020, (Table 51).

Table 51.--Summary of Current and Projected Floodwater Damages, Blackwater-Lamine River Basin, Missouri

		Average annual damages			
		Current flood damages	Projected flood damages without resource development		
Subbasin	Flood plain	1970	1980	2000	2020
	---acres---	- - - - - -	thousands of dollars	- - - - -	
Blackwater	66,240	1,671.9	2,189.2	2,544.8	2,783.9
Lamine	47,130	1,266.7	1,611.6	1,943.2	2,108.6
Total Basin	113,370	2,938.6	3,800.8	4,488.0	4,892.5

1. Blackwater Subbasin

Projected floodwater damages in the Blackwater Subbasin are over $2.5 million annually (Table 52). Of the 66,240 acres of flood plain in the Blackwater Subbasin, 32,940 acres of 50 percent are on the main stem and its small direct tributaries. The area of flooded bottom land for the Blackwater Subbasin changes with the frequency of the flood (Table 53). A 50-year frequency flood inundates 100 percent of the evaluated area while a 1-year frequency flood inundates 32 percent. Two thirds of the flood bottom land is inundated by 3 feet of water for a 50-year frequency flood and less than 10 percent of the bottom land is inundated to such depths by an annual flood.

The pilot channels in the Blackwater Subbasin created problems that continue. According to the records at the USGS Blue Lick Stream gage, the channel has aggraded 6 feet from 1922 to 1975. During this same period the upper reaches of Davis Creek and the Blackwater River have degraded 30 feet or more. As a result, the fall of the stream has been reduced 36 feet from an original 85 feet to the present 49 feet in a distance of 50 miles. In the "channelized" reaches the channel continues to erode and channel capacity increases; in the downstream reaches the channel capacity continues to decrease resulting in more flooding, swamping and sediment deposition. In the upstream tributaries relentless headcutting continues.

Flooding causes agricultural damages to cropland, pasture, machinery and livestock.

Other flood damages include roads, bridges, buildings and debris removal.

Figure 24.--Bottom land Problems by Major Land Use and Subbasin, Blackwater-Lamine River Basin, Missouri, 1970

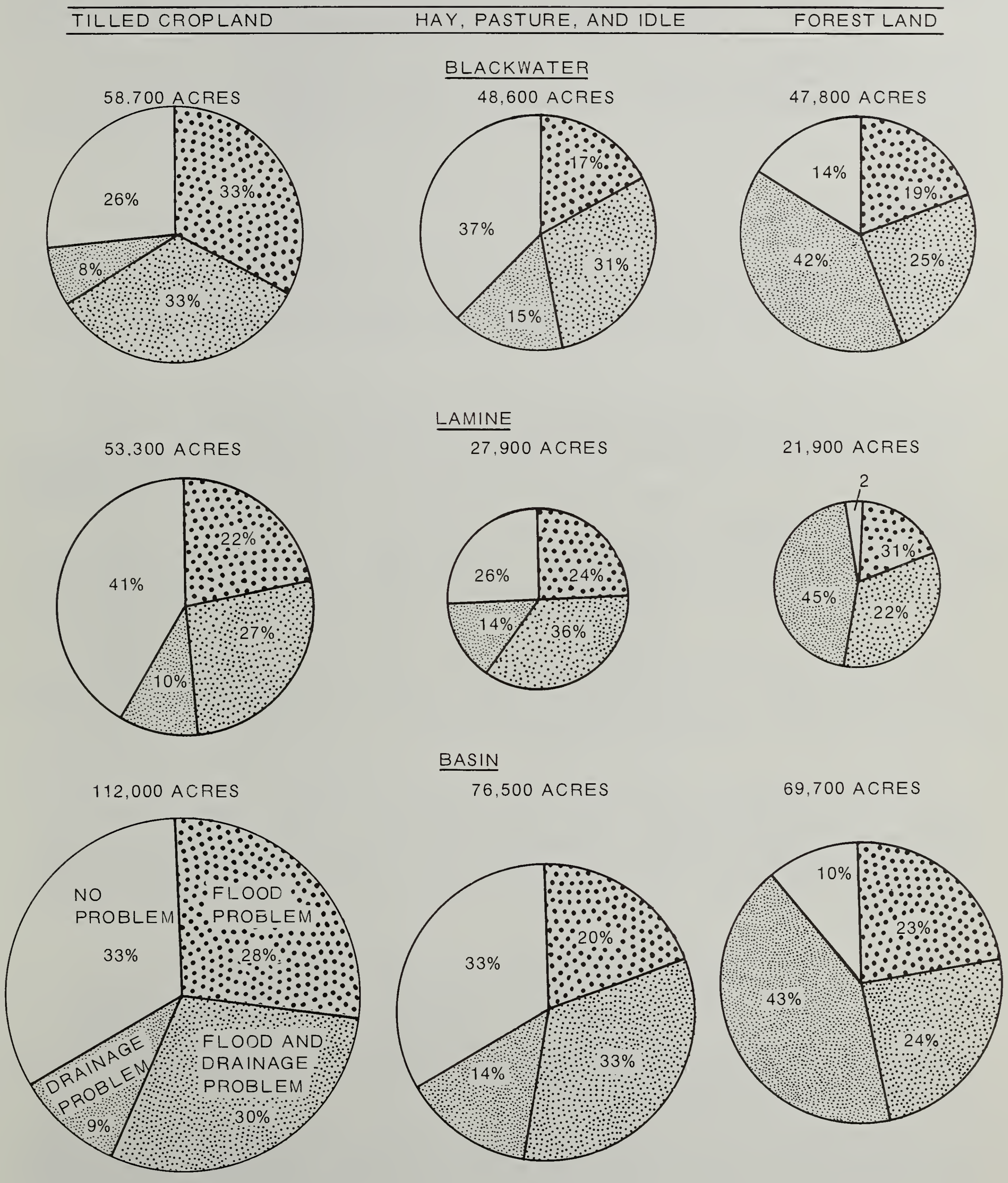


Table 52.--Floodwater Damages for Year 2000, Blackwater River Subbasin, Blackwater-Lamine River Basin, Missouri

Description	Floodwater damages
	(dollars)
Crop and pasture	1,812,790
Other agricultural	181,280
Roads and bridges	148,300
Sediment	52,290
Scour	94,990
Swamping	11,800
Streambank erosion	12,050
Subtotal	2,313,500
Indirect	231,350
Total damage	2,544,850

Price base: Current normalized prices, WRC, February 1974

Table 53.--Bottom Land Area Inundated by Frequencies, Blackwater Subbasin, Blackwater-Lamine River Basin, Missouri

Frequency	Total acres	Percent of total	Percent of total over 3 feet deep
Years return interval			
50	66,240	100	66
25	58,290	88	51
10	51,670	78	38
5	46,400	70	29
2	23,780	51	20
1	21,200	32	9

a. Pilot Watershed

The East Branch of the South Fork of the Blackwater River Watershed was designated a pilot watershed project in September, 1953. The watershed has a drainage area of 19.7 square miles of which 1079 acres is bottom land. The principle problems were flooding, erosion and sediment. The project completion report dated June, 1961 reported annual floodwater and sediment damages of $12,000.

b. South Fork of Blackwater River Watershed

The South Fork of Blackwater River Watershed was planned under the authority of PL-566 in July, 1962. A revised work plan was completed in July, 1972. The watershed has a drainage area of 102.46 square miles excluding the pilot watershed (Figure 25).

The problems reported were flooding, erosion, and sediment. Also needs were identified to enhance fish and wildlife, supply municipal water for the city of Holden and nearby areas, and increase the water based recreational facilities in the watershed.

Land treatment measures will be installed on 12,500 acres plus 590 acres of forest land treatment. Structural measures consist of 11 floodwater retarding structures, 10 stabilization structures and one multiple-purpose structure. Four floodwater retarding structures and nine stabilization structures have been built under the original work plan.

Floodwater damages from the 5,382 acres of flood plain amounted to $147,030 annually. Joint benefits will be realized downstream as structural measures in other watersheds are installed.

c. North Fork-Honey Creek

The North Fork-Honey Creek Watershed was authorized for planning December, 1967 under the authority of PL-566. Planning is inactive at the present time because of lack of local interest. The watershed has a drainage area of 97.15 square miles. The total flood plain has 7471 acres with an average annual flooded area of 3711 acres.

d. Post Oak

Post Oak Creek is a major headwater tributary of the Blackwater River. It contains 135.52 square miles and enters the Blackwater River at State Highway 13 (Figure 25).

The straightening of the channel over many years caused channel degradation and bank erosion for some reaches. Bank full velocities which vary from 1.3 to 6.8 feet per second have eroded the stream channel creating widths of 50 to 130 feet wide and depths of 8 to 24 feet.

The flood plain widths are 1900 feet on the tributaries to 3500 feet near the mouth of Post Oak Creek. There are 6830 acres in the flood plain. The lower reaches flood an average of two times per year. The average annual area flooded is 5830 acres. A 50-year frequency flood will result in a flood duration of from 11 to 23 hours.

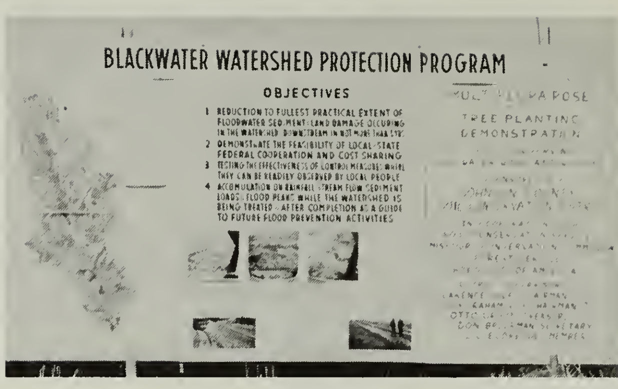
Scour erosion damages 189 acres annually. Damages from sediment and swamping are minor with only 12 acres effected. Average annual damages from these sources amount to $6730. Total annual damages are $299,020 with 74 percent of this total from crops and pastures.

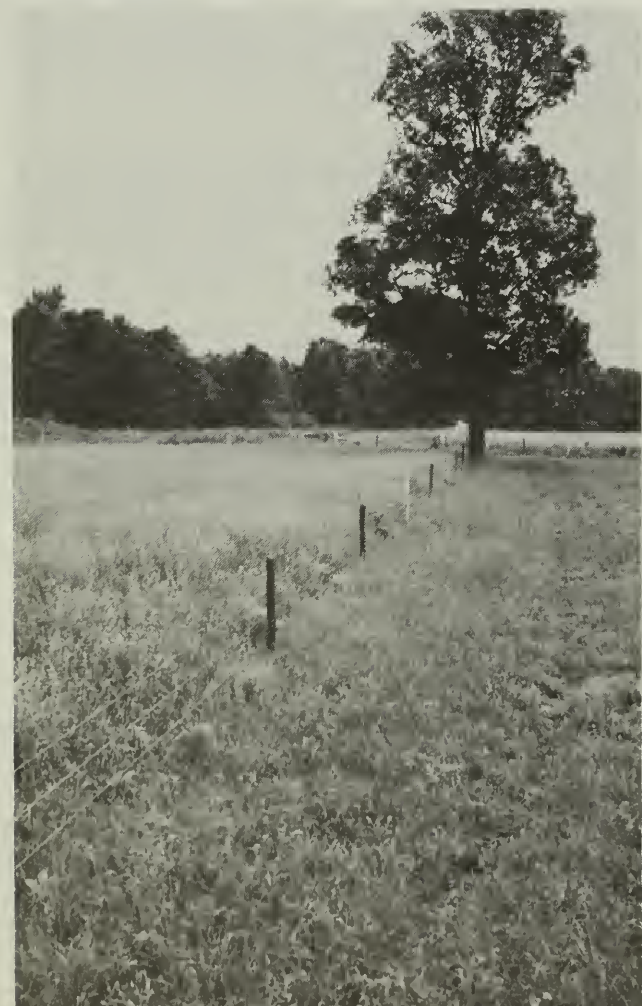
e. Upper Blackwater River - Reach 1-2

Reach 1-2 of the Upper Blackwater River extends from Missouri Highway 13 to Valley City, a distance of 8.7 miles (Figure 25).

A large amount of streambank erosion has occurred since the excavation of the pilot channel was completed in 1913. The channel straightening increased the slope through this reach to an average of 2.6 feet per mile. The accelerated streambank erosion has resulted in channel widths of 150 to 200 feet and depths of 20 to 30 feet. Flood plain widths vary from 775 to 4000 feet. The total flood plain area is 4870 acres.

The measures installed in the South Fork of Blackwater River Watershed Project are providing benefits to the sponsors.





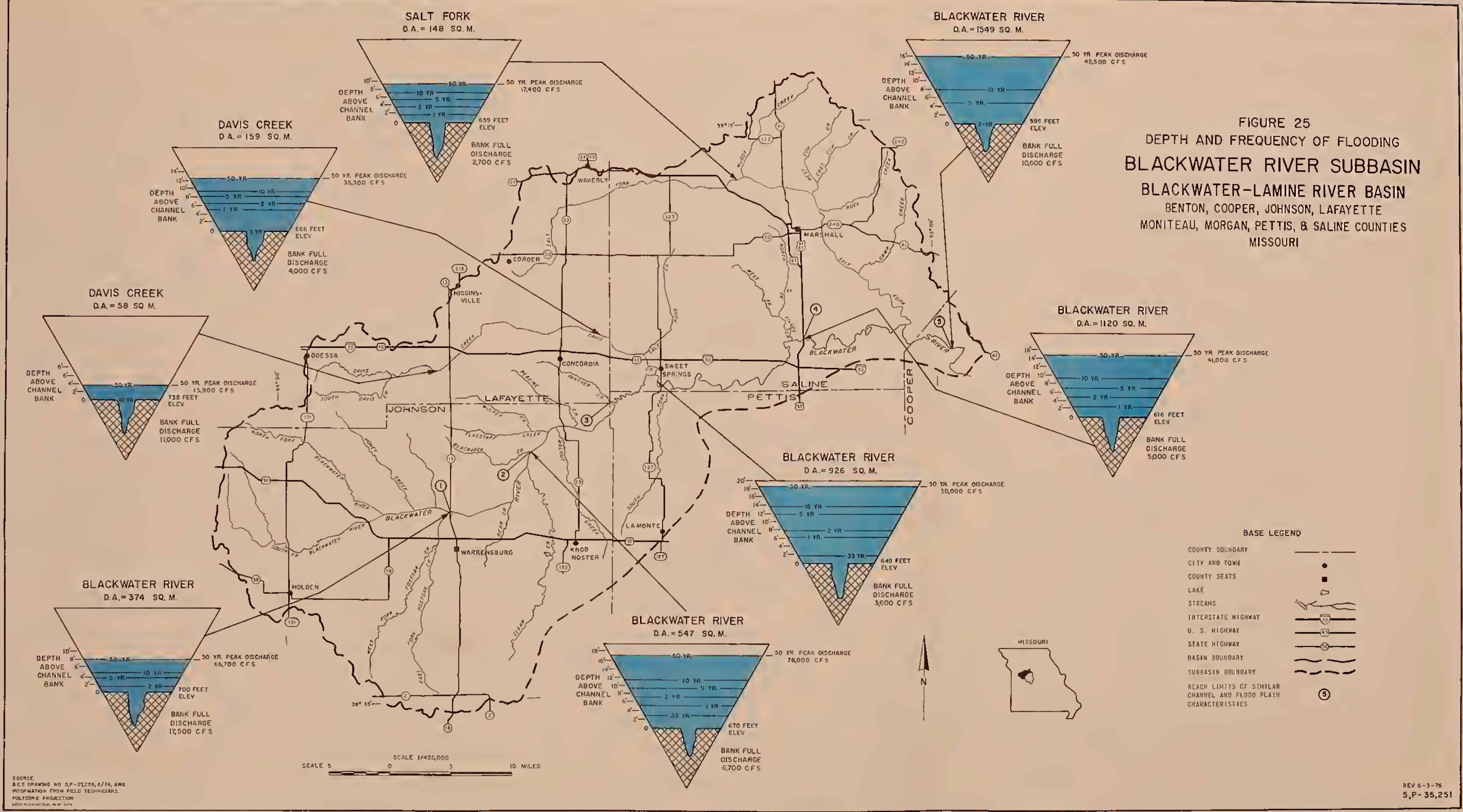


FIGURE 25
DEPTH AND FREQUENCY OF FLOODING
BLACKWATER RIVER SUBBASIN
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI

Bank full capacity is 17,500 CFS at 374 square miles, the upper end of the reach, and 6700 CFS at 535 square miles, the lower end. Flooding occurs once per year at the upper end and three times per year at the lower end. A 50-year frequency flood will result in depths of 18 feet and a duration of flooding of from 30 to 50 hours.

Scour is serious in this area with 338 acres damaged. Sediment damages about 14 acres and swamping damages 18 acres. Composite values vary from $90 to $165 per acre. Crop and pasture damage accounts for 75 percent of the $246,000 annual damage.

f. Blackwater River - Reach 3-4

Reach 3-4 of the main stem of the Blackwater River extends from the Johnson-Pettis County line to U.S. Highway 65, a distance of about 35 miles (Figure 25). The drainage area at the upper end of the reach is 670 square miles and at Highway 65, 1120 square miles. A major tributary, Davis Creek (241.23 square miles), enters near the upper end of the reach.

The channel slope averages 1.6 feet per mile with a capacity of 5000 CFS. Widths vary from 100 to 160 feet and depths of 12 to 22 feet. Flood plain widths range from 1300 to 2700 feet. Total flood plain area in this reach is 5400 acres. During the 20-year period from 1951 through 1970, records at the Blue Lick Stream gage showed 10 floods inundating over half the flood plain and 21 floods inundating less than half the flood plain. Duration of flooding from a 50-year frequency flood will vary from 70 hours at the upper end of the reach to 115 hours at the lower end. Depths will reach 30 feet over bank. The channel, in some parts of the reach, overflows up to five times per year resulting in 8640 acres flooded on an average annual basis.

There are 108 acres of cropland damaged annually from scour and 162 acres from sediment deposition. Sediment build-up has been a problem for nearly 60 years since channel excavation was completed in 1913. Elevations at the Blue Lick gage indicate that sediment has filled the channel 9 feet during this period. Indications are that the flood plain has raised at the same rate. Cropland, varying from 20 to 60 percent, results in gross composite acre values ranging from $43 to $124 per flood plain acre. Total damages projected to the year 2000 amount to $276,000 annually. Seventy-four percent of this amount is from crops and pastures.

g. Blackwater River - Reach 4-5

Reach 4-5 of the Blackwater River extends from U.S. Highway 65 south of Marshall to the junction of the Lamine River (Figure 25). This lower reach extends for 23 miles and has one major tributary, Salt Fork with a drainage area of 353.71 sqaure miles. The upper end of this reach has about 1100 square miles of drainage and the lower end 1549.33 square miles at the outlet of the Blackwater River.

Even though the channel slope is .5 foot per mile, the other hydraulic parameters of the channel are considerably improved. The channel widths range from 140 to 190 feet with depths from 22 to 23 feet. The channel capacity is 10,600 CFS at the outlet of the Blackwater River. The flood plain

is narrow and sloping rather than flat like most upstream reaches. Widths vary between 870 and 2100 feet. There are 3800 acres of flood plain in this reach.

The frequency of flooding ranges between one and three years. Depths of flooding range from 12 to 20 feet. Duration of inundation is 130 hours from a 50-year frequency flood. Average annual acres flooded is 500 acres, which is only about 13 percent of the maximum flood plain. Scour is not a problem in this reach although 30 acres are damaged from sediment annually.

The flood plain averages about 75 percent cropland resulting in gross composite acre values up to $174. Floodwater damages are considered small with crop and pasture damages averaging less than 5 percent of the gross composite value. Total damages are estimated at $34,000 annually.

h. Davis Creek

Davis Creek, a northern tributary of the Blackwater River, outlets near Sweet Springs and heads near Odessa (Figure 25). Total drainage area is 241.34 square miles. Most of the main channel in Lafayette County was straightened around 1908. Very little work has been done on the channel in Saline County.

Since 1908 when the pilot channel was excavated, streambank erosion has widened and deepened the channel in Lafayette County. It is now from 120 to 240 feet wide and 18 to 30 feet deep. The channel below the Lafayette-Saline County line to the Blackwater River is filling with sediment, and is narrower, 60 to 170 feet wide, and shallower, 11 to 16 feet deep.

Flood plain widths range from 2000 to 4000 feet on the main stem and 1000 to 1500 feet on the tributaries. The total flood plain area is 13,320 acres. Above State Route 13, the channel capacity is 15,900 CFS with a drainage area of 58 square miles. From I-70 to the county line the frequency of bank full flow changes from once in 23 years to every two years. The unimproved channel in Saline County is silted and floods from two to four times annually. Its channel capacity is 4000 CFS with a drainage area of 159 square miles. Depths of flooding range from zero to eight feet deep in the upper portion but increased to 20 feet near the outlet. Duration of flooding is generally less than 24 hours except near the outlet, where durations increase to 46 hours. In 1973, floodwaters inundated Interstate Highway 70 near Sweet Springs at a drainage area of 240 square miles.

Although the capacity of the main stem channel is high, the joint flood plain is often flooded from side tributaries. These tributaries are degrading upstream from their confluence with the main stem.

The main stem flooding damages 8100 acres annually; scour damages 740 acres; sediment damages 1693 acres and swamping affects 51 acres. Much of the sediment outwash is fertile. As much as 10 feet of sediment has been deposited downstream from the end of the pilot channel. In this area land use has changed from cropland to pasture and trees. Composite acre values vary considerably with the highest at $186. Total damages are estimated at $397,600 with 65 percent of this amount coming from crops and pasture.

i. Salt Fork

Salt Fork, a northern tributary of the Blackwater River has a drainage area of 353.71 square miles and outlets into the Blackwater River about 7 miles above its mouth (Figure 25).

Above the city of Marshall, the channel varies in width from 60 to 90 feet and in depths from 6 to 16 feet. Below Marshall the channel widens from 100 to 140 feet with depths from 12 to 19 feet. Channel slopes are about 4 feet per mile for most of the length and flatten to 1 foot per mile near the outlet. Flood plain widths above Marshall vary from 1000 to 2600 feet and below Marshall from 450 to 900 feet. Near the junction with Blackwater River, the flood plain widens to 1800 feet. The total flood plain area is 13,150 acres.

Some channel straightening has been completed in the area from Waverly to Malta Bend. The bank full capacity is 2700 CFS at a drainage area of 148 square miles. Flooding occurs from 2 to 5 times annually.

Depth of flooding from a 50-year frequency flood varies from 5 feet in the upper reaches to 13 feet in the lower reaches. Durations from this large flood range from 15 hours to 50 hours below Marshall. Average annual area flooded is 10,240 acres. Nearly 500 acres are damaged by sediment deposits, reducing crop yields. Minor damages are caused by flood plain scour. The flood plain along the main stem has about 70 percent cropland. Gross composite acre values range up to $180. Total damages are $513,120 with 72 percent of this amount coming from crops and pastures.

2. Lamine Subbasin

The major tributaries of the Lamine Subbasin are Flat Creek, Richland Creek, Muddy Creek and Heath Creek. Flat Creek, Muddy Creek and the Lamine River account for 90 percent of the annual damages. Projected floodwater damages in the Lamine Subbasin are over $1.9 million annually (Table 54).

Table 54.--Floodwater Damage for Year 2000, Lamine River Subbasin, Blackwater-Lamine River Basin, Missouri

Description	Floodwater damages
	(dollars)
Crop and pasture	1,113,450
Other agricultural	111,350
Roads and bridges	95,380
Sediment	67,950
Scour	336,800
Swamping	41,610
Subtotal	1,766,540
Indirect	176,660
Total damage	1,943,200

Price base: Current normalized prices, WRC, February 1974

The 50-year frequency flood plain evaluated is 47,130 acres, while the average annual area flooded consisted of 38,440 acres (Table 55). For areas over 3 foot deep, the 50-year frequency included 70 percent of the bottom land; the 1-year frequency included only 2 percent.

Table 55.--Bottom Land Area Inundated by Frequencies, Lamine Subbasin, Blackwater-Lamine River Basin, Missouri

Frequency	Total acres	Percent of total	Percent of total over 3 feet deep
Years return interval			
50	47,130	100	70
25	44,770	95	56
10	40,060	85	39
5	34,400	73	26
2	26,390	56	11
1	16,500	35	2

a. Flat Creek

Flat Creek is one of the major headwaters tributaries of the Lamine River. It has a drainage area of 400.37 square miles (Figure 26).

The main stem channel width varies from 110 to 200 feet and the depth varies from 10 to 18 feet. The flood plain along the main stem is 1300 to 4100 feet wide and has 9700 acres. Flood plain on the tributaries to Flat Creek are narrower and total 5730 acres. The channel capacity is 4100 CFS at 151 square miles and 3500 CFS at 400 square miles. Flooding on the main stem varies from more than one flood per year to one flood in five years on the tributaries. Duration of flooding from a 50-year frequency flood ranges from 19 to 26 hours for drainage areas less than 247 square miles. The duration of flooding ranges from 43 to 50 hours in the larger drainage areas.

Average annual area flooded on the main stem of 9700 acres is equal to the total flood plain area. Average annual area flooded on the tributaries amounts to 2865 acres, or about 50 percent of its flood plain. Damages from sediment, scour and swamping are $162,700 annually. There are 513 acres damaged from sediment, 3394 acres from scouring and 442 acres from swamping. Gross composite acre values along the main stem average $119 per acre and the tributaries average $152. Total damages are estimated at $592,860 annually with 70 percent of this damage along the main stem. Fifty-five percent of the damages are from crops and pastures.

b. Richland Creek

Richland Creek with a drainage area of 137.46 square miles joins Flat Creek to form the Lamine River (Figure 26). Gabriel Creek is a major tributary of Richland Creek entering two miles above its mouth.

Richland Creek is a typical Ozark stream with shallow gravel bottom channels having a relative high channel capacity. The channel widths on Richland Creek vary from 80 to 200 feet and depths vary from 4 to 12 feet. Gabriel Creek channel widths range from 60 to 170 feet and depths from 5 to 11 feet.

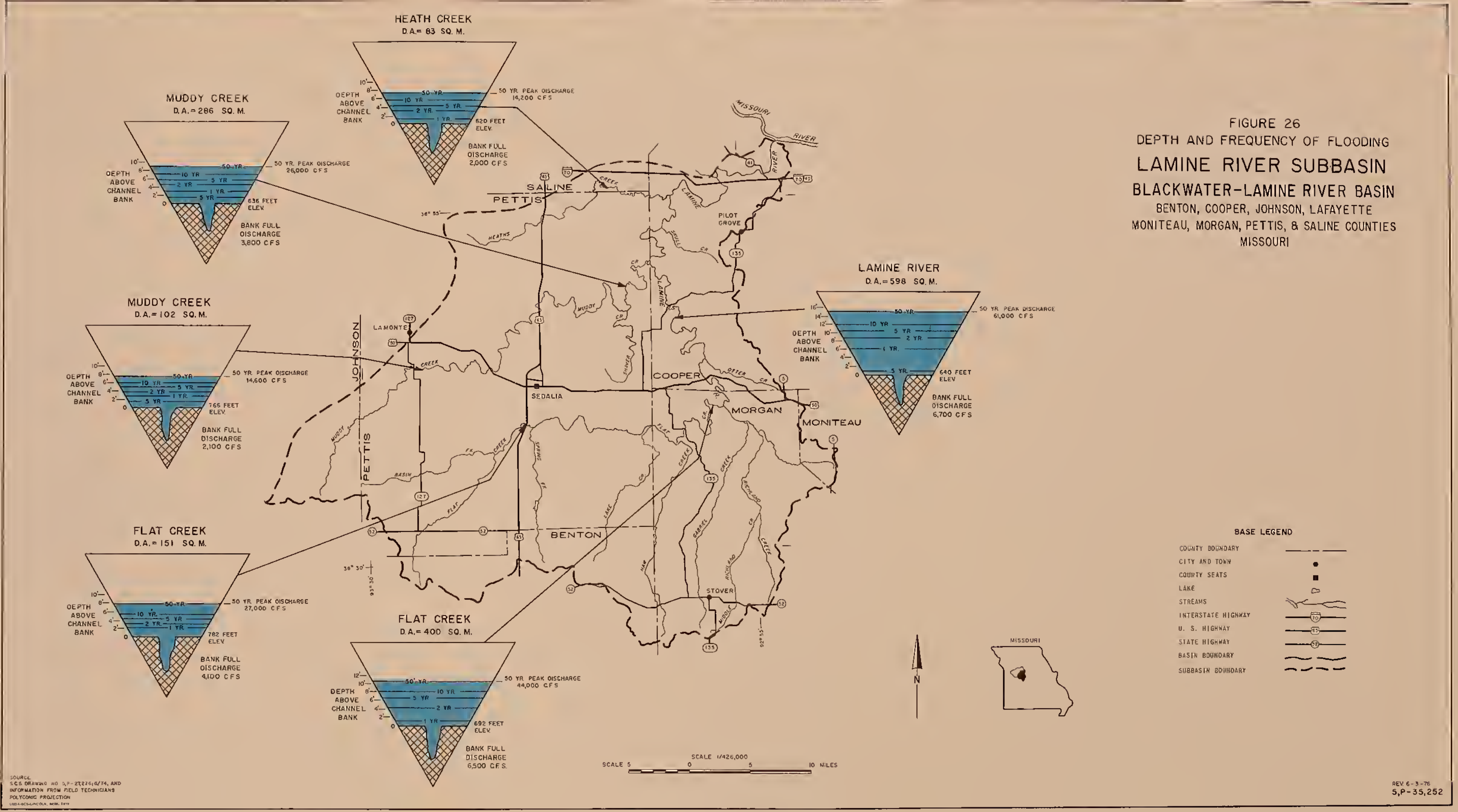


FIGURE 26
DEPTH AND FREQUENCY OF FLOODING
LAMINE RIVER SUBBASIN
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI

The flood plain ranges from 800 to 1200 feet wide and widens to 2500 feet below its junction with Gabriel Creek. The total flood plain has 4140 acres. Bank full capacities are exceeded between once each year and once every eight years. Some sections of the channel near the outlet floods more than once per year. Duration of flooding for a 50-year frequency flood along Gabriel Creek varies from 11 to 27 hours and along the main stem of Richland Creek from 26 to 31 hours. Depths of flooding range from 4 to 9 feet. The average annual area flooded is 1615 acres or 39 percent of the total flood plain. About 400 acres are damaged from sediment and 668 acres from scour at a cost of $26,360 annually. The gross composite acre value is $136. Total annual damages are $84,620 of which 55 percent is for crops and pastures.

c. Muddy Creek

Muddy Creek is a major tributary of Lamine River with a drainage area of 294.85 square miles (Figure 26). Severe problems occur from flooding, scour and sediment.

The upper reaches of the channel averages 60 feet wide and 11 feet deep and in the lower reaches channel widths are 140 feet and 17 feet deep. The channel capacity is 2100 CFS at 102 square miles and 3800 CFS at 286 square miles drainage areas. Channel slopes of Muddy Creek vary from 2.5 feet per mile to about 4.5 feet, and the slopes on the tributaries range up to 16 feet per mile. Flood plain widths vary between 1000 and 2700 feet. Some of the wider flood plain are in the upper reaches. There are 12,710 acres of flood plain. Frequency of flooding along the main stem varies between one and four times per year. The duration of a maximum flood is 18 hours in the upper reaches and increases to 53 hours near the outlet. Depth of flooding of a 50-year frequency flood varies from 3 feet in the smaller drainages to over 10 feet deep at the outlet.

Average annual area flooded is 13,050 acres which slightly exceeds the total flood plain area. Some of the most severe scour damages in the Lamine Subbasin are along Muddy Creek. About one-fourth of the total flood plain or 3126 acres are damaged by scour at an estimated annual damage of $112,450. An additional 471 acres are damaged by sediment and the estimated annual damage is $28,920. Land use in the flood plain is 62 percent cropland, 21 percent pasture and 15 percent forest. About 85 percent of the cropland is used for corn and soybeans. The value of a gross composite acre is $92 in the upper reaches and increases to $144 in the lower reaches. Total annual damages are $553,440 with about 61 percent for crops and pastures.

d. Heath Creek

Heath Creek outlets into the lower reaches of the Lamine River (Figure 26). It has a drainage area of 106.82 square miles. The stream generally parallels Interstate 70 Highway.

Channel widths vary from 60 to 120 feet and depths from 7 to 16 feet. Channel capacity is 2000 CFS at 83 square miles. Slopes vary from 2 feet per mile at the outlet to over 12 feet per mile in the upper reaches. The flood plain has 3110 acres. The width varies between 650 and 1600 feet.

Flooding occurs between one and two times per year. Average annual area flooded is 2620 acres. The duration from a 50-year frequency flood is 16 hours at the upper end to 34 hours at the lower end. Scour damages are severe on 378 acres. Sediment deposits adversely affect about 51 acres, and swamping 10 acres. These damages are estimated at $17,120 annually.

The flood plain is farmed intensively with about 80 percent in cropland. Gross composite acre values along the main stem vary from $135 to $172. Total floodwater damages are $120,350 annually of which 66 percent is from crop and pasture.

e. Lamine River

The Lamine River winds through a valley surrounded by rolling hilly uplands. The upper end of the Lamine River formed by Flat and Richland Creeks have a drainage area of 552.35 square miles (Figure 26). The drainage area at the confluence of Blackwater River is 1079.66 square miles.

The channel widths vary between 200 and 300 feet and depths vary between 16 and 25 feet. The bank full channel capacity at the Clifton City Stream gage is 6700 CFS at 598 square miles of drainage area. Channel slopes vary from 4 feet per mile near U.S. Highway 50 to 1 foot per mile near its junction with Blackwater River.

The flood plain width varies from 2200 to 4200 feet. High terraces comprise 5000 acres of the 11,740 acres flood plain. Stream gage records at Clifton City indicated the years 1951 through 1970 produced 13 floods that inundated over 50 percent of the flood plain. In addition 32 floods inundated nearly one-half of the flood plain. All county roads and bridges in the flood plain have been inundated from larger floods. Floodwaters inundated the railroad at the Clifton City Stream gage in 1969 and occasionally inundate Missouri Highway 135. Flooding durations of the larger floods averages 60 hours and depths vary from 10 to 15 feet. Average annual acres flooded is 8500 acres. Scour is severe with 3130 acres damaged annually. Also 272 acres are damaged by sediment. The total of these land damages is $143,450. With an average of 85 percent of the flood plain in cropland, the composite acre values are $179. Total annual floodwater damages are $591,930, with 60 percent being crop and pasture damages.

OUTDOOR RECREATION

The national trend of increased participants in outdoor recreation activities is apparent in Missouri. From 1967 to 1972 the number of visitors at Knob Noster State Park has more than tripled. This increase in use has resulted in site deterioration which in turn decreases the quality of the recreation experience. The heavy use of other recreational areas in the basin also indicates this demand.

Projected demand for recreational facilities in the basin was estimated by analyzing travel time and other parameters from 21 population centers. Four time zones, ranging between one-half and two hours for each of the population centers, indicated that 74 percent of the demand for recreation is generated from population centers outside of the basin (Table 56). Of the total basin demand, 65 percent is from the Kansas City Metropolitan Area.

Table 56.--Influences of Outside Population Centers on the Recreation Demand, Blackwater-Lamine River Basin, Missouri 1/

Time zone	Population centers basin demand 1/	Kansas City basin demand
	percent	
1/2 hour	95	95
1 hour	95	81
1 1/2 hour	72	60
2 hours	65	55
Total basin	74	65

1/ Includes Kansas City, Columbia, Jefferson City, Boonville, Windsor, Clinton, Lexington, Harrisonville, Pleasant Hill, and Belton.

Beyond the one-half hour time zone, other population centers are influencing the increase. This explains the higher demand in the eastern portion of the one-hour time zone and the various levels of demand in the one and one-half hour time zone.

Another parameter of recreation demand is Population Access Intensity (Map 21). This is the number of potential persons able to reach a given area to recreate and is expressed in persons per square mile.

The population access intensity determines the relative pressure of population centers on the basin based on travel time. Thus it is relevant not only for assessing the special demand for recreation but also for competing uses of land such as housing.

The differences between the population access intensity for 1970 (Map 21) and 2000 (Map 22) are the result of the projected population growth rates in each of the population centers considered in this study. The projected population growth is greater in the eastern portion than in the western portion of the basin, as indicated on Map 22 where none of the area has a population access intensity of less than 100.

Recreation consists of a host of activities. The classification of activities are based on that used for the Missouri Outdoor Recreation Study. The demand for each activity was based on population intensity and use rates from the Missouri Outdoor Recreation Study. The estimated demand for each activity is presented by four time periods (Table 57). The additional units needed to meet demand for each activity are also presented (Figure 27). The total, present development of resources will support only 18 percent of the demand for recreation. If facilities were provided only for population centers in the basin, the need for additional development would be much less, especially for such activities as canoeing, sailing, winter sports, picnicking, swimming and outdoor games.

The western and central section of the basin has higher demand for fishing. The bordering Missouri River supplies some of these needs. Fishing is a key activity that other activities can be planned around.

The potential demand for boating considers the type and size of boats. Large boating, associated with water skiing, is considered to have medium

potential demand because of existing and proposed large reservoirs nearby, (Lake of the Ozarks and Harry S. Truman). The boating and canoeing levels on streams are presently below capacity because of limited access points. Therefore, provisions for more access points is a key need for increasing boating on streams.

The potential demand for picnicking ranges from high in the west and north sections of the basin to medium in the remainder. Sufficient picnic areas are available in and around Sedalia. Camping has a high potential demand throughout the basin. The highest demand is in the west.

Horseback riding is usually associated with natural and scenic areas and may be in conjunction with other recreation enterprises such as vacation farms or group camps. The demand for riding trails is highest in areas adjacent to local population centers. The lack of population centers next to significant natural areas may act as a limiting factor.

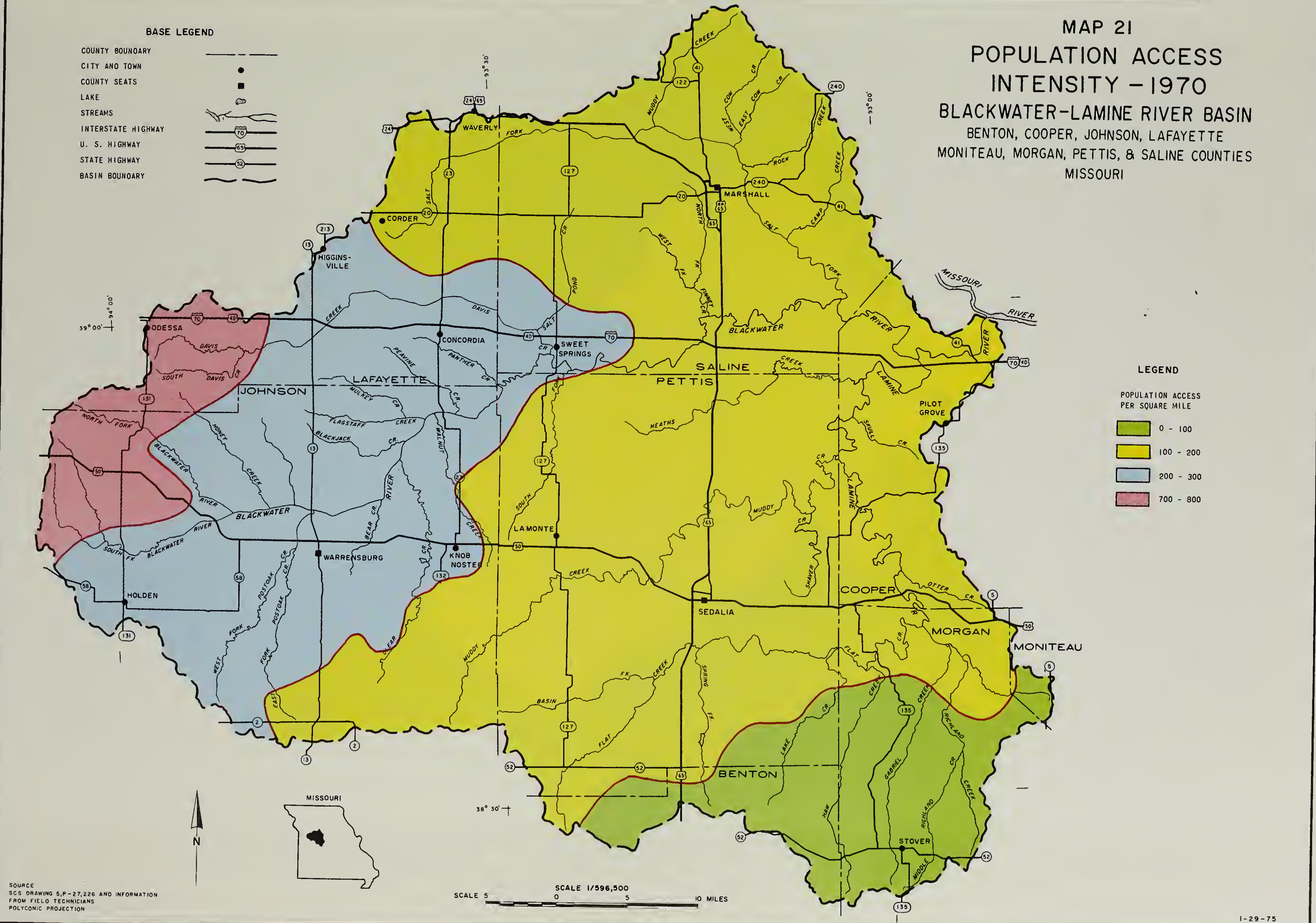
Shooting of stocked, domestic game under conditions simulating natural hunting may be done on preserves with club arrangements or commercial situations. Although shooting preserves for duck, pheasant and quail show high potential; the operation is complicated and demanding. The combination of climate and soils produces a high potential for the development of preserves. At present, however, lack of existing habitat and game population and legal restrictions on game seasons and hunting areas preclude high potential demand for developments involving pheasants or mallard ducks.

Limiting and attracting values of natural resources were measured to estimate the suitability and potential for development of recreation areas. Features of resources within the basin were related to features of other regions throughout Missouri resulting in a value labled Limitations/Attractions Index (L/A) (Map 23).

The Lamine River received the highest L/A index, primarily because of better water characteristics. Richland Creek ranked a close second while receiving the highest ratings in special function because of its Ozark appearance. Those streams which received an L/A index of one or below were rated low primarily because of their water chacteristics. The L/A of any stream is subject to change with any development that affects the characteristics used. Developing reservoirs, improving roads, and reducing pollution in streams are some characteristics that can improve the L/A index. The eastern part of the basin has higher L/A values than the western and northern parts. However, the west has a much higher population access because of the Kansas City Metropolitan Area. Many of the higher L/A ratings in the eastern part are the result of the "Ozarks" terrain.

One of the important factors associated with recreational use of resources is the availability of good access roads. Relative to other rural areas access to the area is good. Three major east-west and five north-south highways provide excellant arterial access. Secondary roads in the western two-thirds of the basin are also of good quality; 75 percent of the roads are paved. If recreational development of the basin resources occurs, upgrading and extending secondary roads particilarly east of U.S. Highway 65 is needed.

MAP 21
POPULATION ACCESS INTENSITY – 1970
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI



SOURCE
SCS DRAWING 5,P-27,226 AND INFORMATION FROM FIELD TECHNICIANS
POLYCONIC PROJECTION

1-29-75
5,0-34,971

USDA-SCS-LINCOLN, NEBR 1975

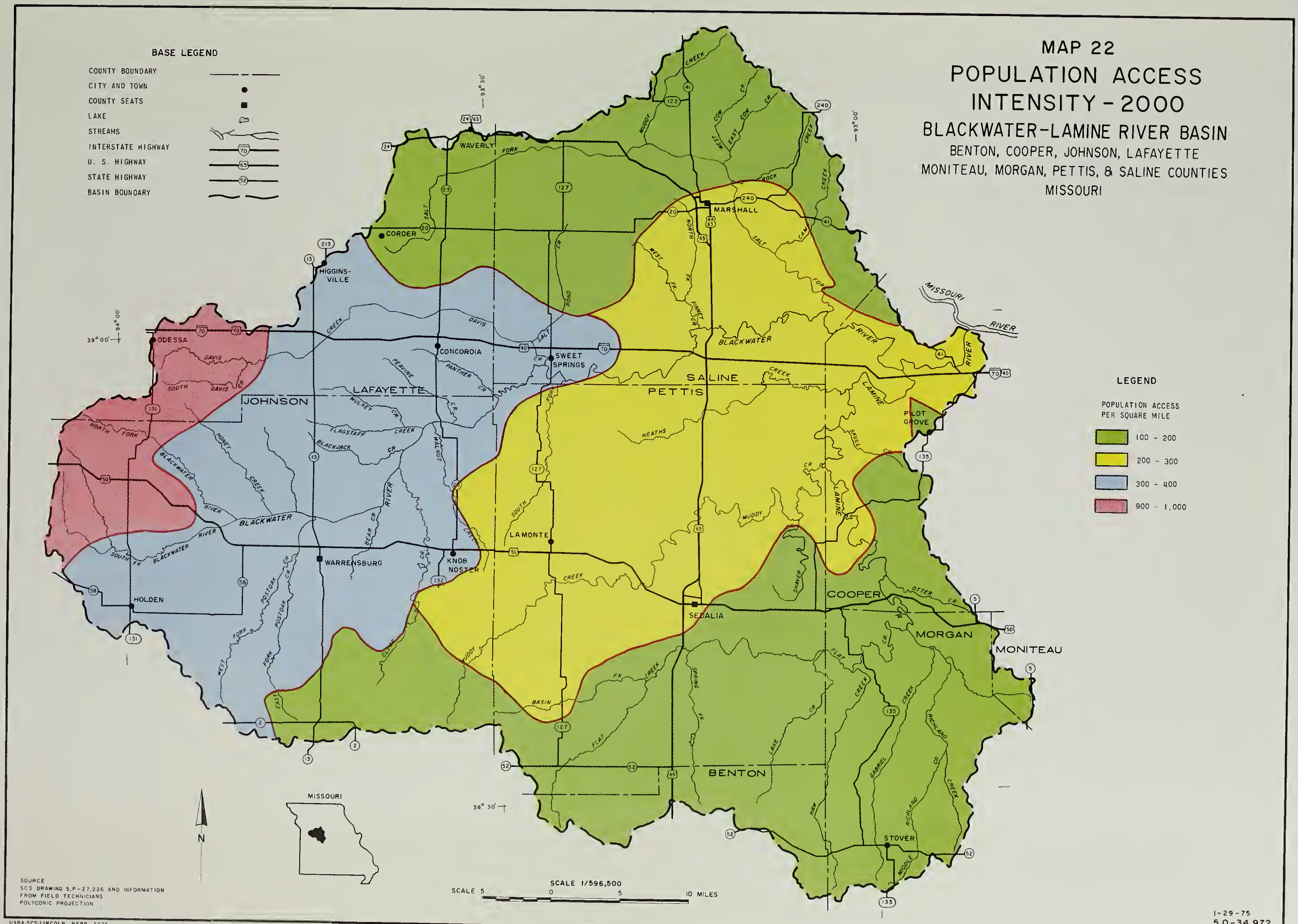
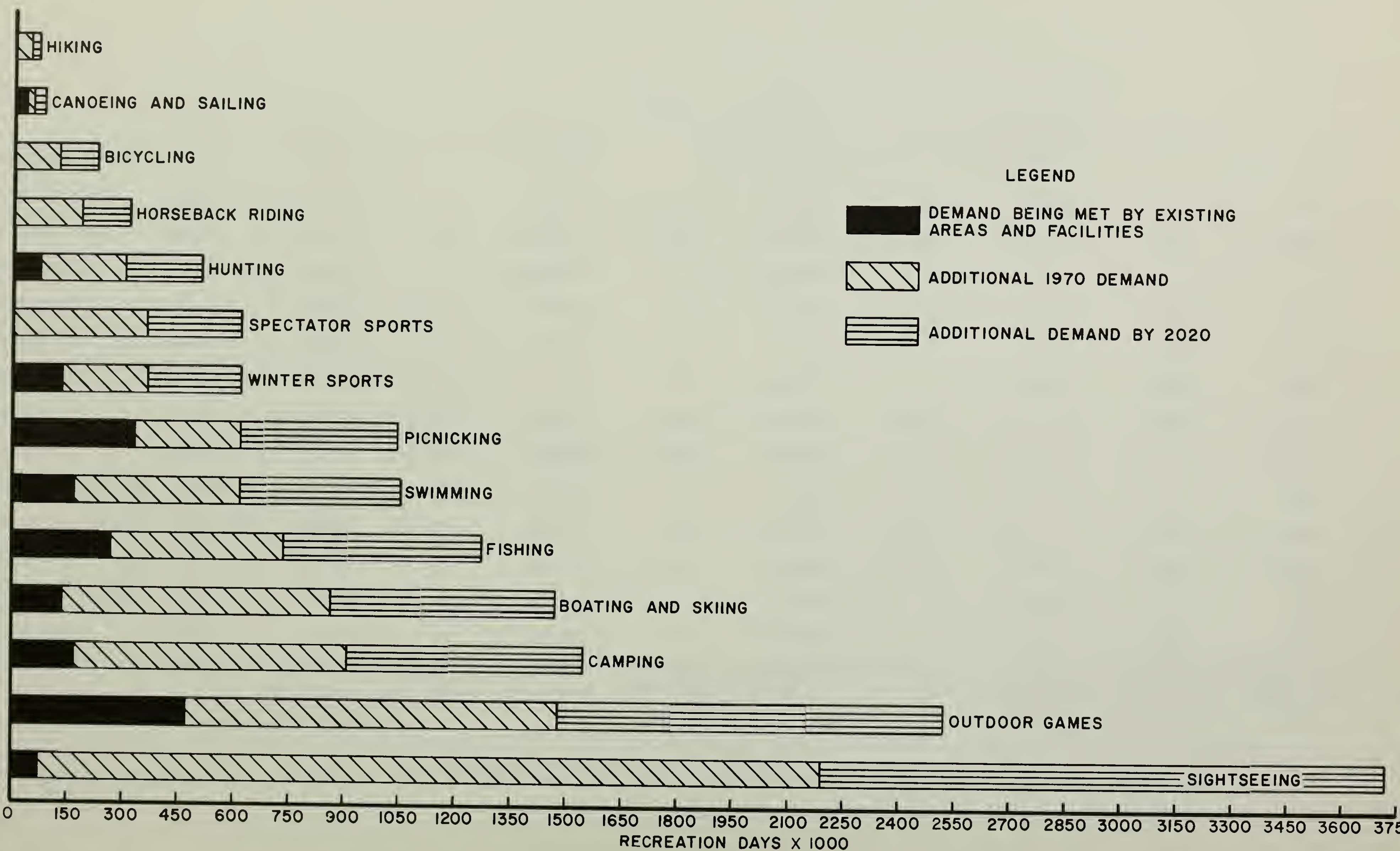
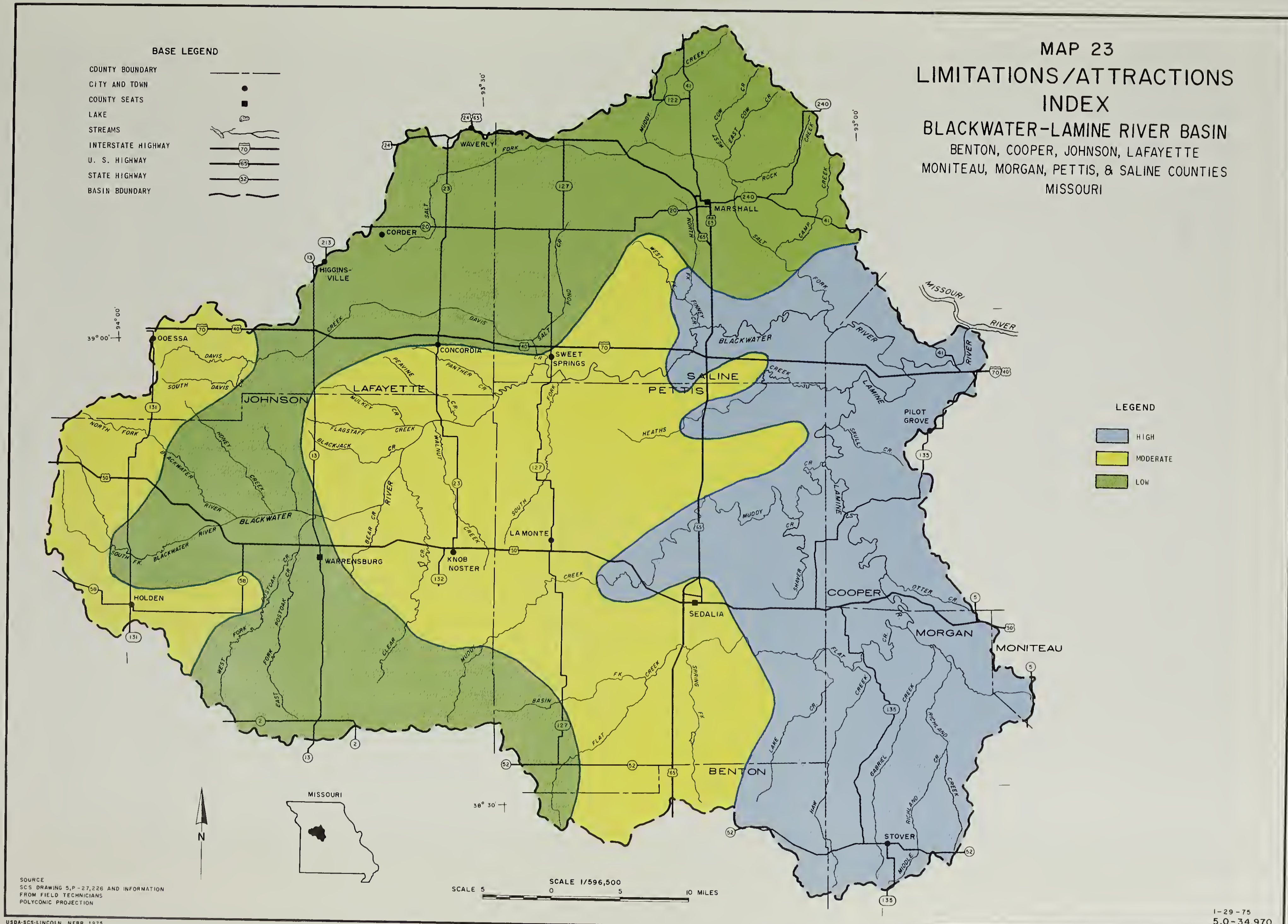

MAP 22
POPULATION ACCESS INTENSITY - 2000
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
INTERSTATE HIGHWAY
U. S. HIGHWAY
STATE HIGHWAY
BASIN BOUNDARY
LEGEND
POPULATION ACCESS PER SQUARE MILE
100 - 200
200 - 300
300 - 400
900 - 1,000
SALINE
PETTIS
JOHNSON
LAFAYETTE
COOPER
MORGAN
MONITEAU
BENTON
MARSHALL
SEDALIA
WARRENSBURG
HIGGINS-VILLE
ODESSA
CONCOROIA
SWEET SPRINGS
KNOB NOSTER
LAMONTE
HOLDEN
WAVERLY
COROER
PILOT GROVE
STOVER
MISSOURI RIVER
BLACKWATER
LAMINE
MISSOURI
N
SCALE 1/596,500
SCALE 5 0 5 10 MILES
39° 00'
94° 00'
93° 30'
93° 00'
38° 30'
SOURCE
SCS DRAWING 5,P-27,226 AND INFORMATION FROM FIELD TECHNICIANS
POLYCONIC PROJECTION
USDA-SCS-LINCOLN, NEBR. 1975
1-29-75
5,0-34,972

Table 57.--Recreation Demand in Recreational Days and Additional Needs Above Existing Resources for Time Periods 1970, 1980, 2000, 2020, Blackwater-Lamine River Basin, Missouri

Activity	Units	1970 Recreation days	1970 Add. needs units	1980 Recreation days	1980 Add. needs units	2000 Recreation days	2000 Add. needs units	2020 Recreation days	2020 Add. needs units	Total add. units needed by 2020
Bicycling	Miles	134,463	72	153,019	10	190,265	19	228,587	20	121
Horseback riding	Miles	185,590	60	211,201	8	262,610	17	315,503	17	102
Fishing	Surface ac.	747,593	8,740	850,760	2,060	1,057,844	4,180	1,270,908	4,260	19,240
Boating & skiiing	Surface ac.	868,933	4,900	988,845	800	1,229,540	1,600	1,477,186	1,650	8,950
Canoeing & sailing	Surface ac.	45,828	72	52,152	42	64,847	85	77,908	87	286
Swimming	Square feet	619,115	250,000	704,553	48,820	876,047	98,000	1,052,495	100,825	497,645
Hunting	Acres	300,524	25,492	341,996	4,150	425,242	8,325	510,890	8,565	47,290
Camping	Acres	910,592	710	1,036,254	120	1,288,488	242	1,548,006	250	1,322
Hiking	Miles	37,307	18	42,455	2.5	52,790	5	63,422	5	30.5
Picnicking	Acres	615,633	100	700,590	29	871,120	60	1,046,576	60	249
Sightseeing		2,188,050		2,490,000		3,096,090		3,719,684		
Outdoor games	Acres	1,484,296	670	1,689,129	135	2,100,279	274	2,523,303	280	1,359
Winter sports	Acres	363,888	8	414,105	2	514,902	3	618,610	4	17
Spectator sports		363,810		414,015		514,791		618,477		
	TOTAL	8,865,622		10,089,078		12,544,855		15,071,555		

Figure 27.--Recreation Demand for Selected Activities - Recreation Days, Blackwater-Lamine River Basin, Missouri




MAP 23
LIMITATIONS/ATTRACTIONS INDEX
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
LEGEND
HIGH
MODERATE
LOW
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
INTERSTATE HIGHWAY
U. S. HIGHWAY
STATE HIGHWAY
BASIN BOUNDARY
MARSHALL
WAVERLY
CORDER
HIGGINS-VILLE
ODESSA
CONCORDIA
SWEET SPRINGS
LAFAYETTE
JOHNSON
SALINE
PETTIS
WARRENSBURG
KNOB NOSTER
LA MONTE
SEDALIA
HOLDEN
PILOT GROVE
COOPER
MORGAN
MONITEAU
BENTON
STOVER
MISSOURI RIVER
MISSOURI
N
SCALE 1/596,500
SCALE 5 0 5 10 MILES
SOURCE
SCS DRAWING 5,P-27,226 AND INFORMATION
FROM FIELD TECHNICIANS
POLYCONIC PROJECTION
USDA-SCS-LINCOLN, NEBR. 1975
1-29-75
5,0-34,970

Another factor to be considered in planning recreational developments is the suitability of soils for a particular activity. Although all soils can be used for recreational activities of some type, some have limitations for camping grounds, waste facilities associated with recreational sites, roads and buildings.

WATER SUPPLY

Wells are the usual source of water for municipal, domestic and industrial use when an adequate quantity and quality can be obtained. In some areas of the basin, however, ground water is low in quality or quantity and surface water is the only practical source of additional water. Streams are usually not dependable as a source of supply.

Concurrent with expanding needs for water supply is the need for waste treatment of effluents. Increased use of water and higher quality standards will necessitate the development of additional water supply and treatment facilities in the future.

1. Central Municipal, Industrial, and Rural Water Supply

Present sources of water supplies for municipal and industrial uses and general ground water quality are presented in Chapter II. The quality of ground water in the area north and east of the Blackwater River is generally below the chemical drinking water standards of the U.S. Public Health Service (Map 24). In addition to low quality, ground water yields are often low in this area.

Population growth rates for the various sized towns, presented in Chapter II, were used to project water supply needs. Although population growth rates for individual towns will vary from those projected, the translation of population growth into water supply needs provides a guideline for predicting the extent of future supply needs.

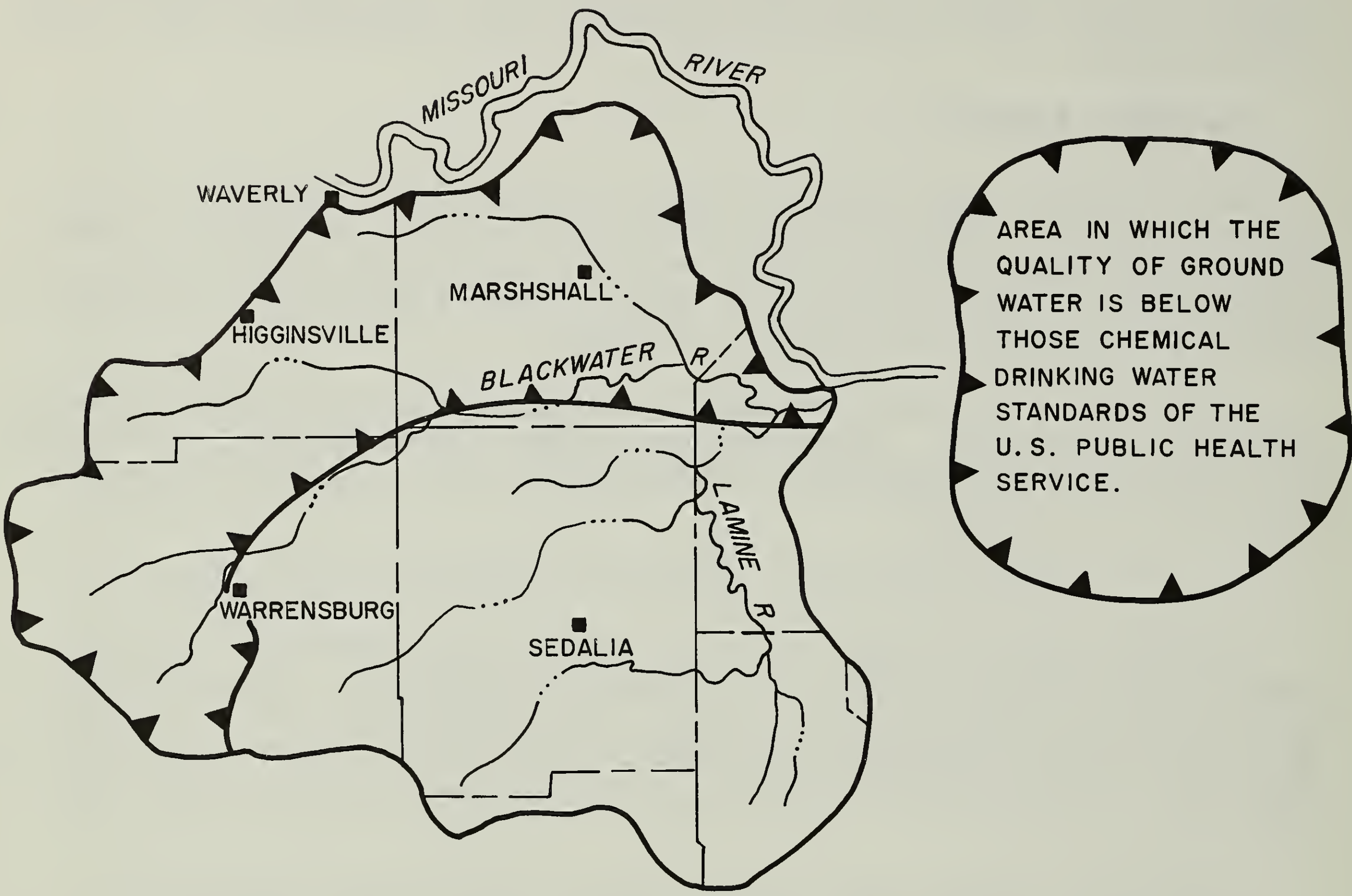
About 22 towns will need additional water supplies. Fourteen towns-Columbus, Fayetteville, Pittsville, Post Oak, Mt. Leonard, Clifton City, Lamine, Blackburn, Bahner, Dresdon, Houstonia, Mora, Florence, and Glenstead-can obtain their supplies from ground water. However, water treatment will be necessary to meet quality standards. Eight towns-Centerview, Chilhowee, Leeton, Sweet Springs, Warrensburg, Higginsville, Lamonte, and Sedalia-will need to obtain supplies by developing storage of surface runoff.

Other towns may need additional supplies which can be obtained from wells, river flows or impoundments. Reservoir sites for surface storage are common throughout the basin.

Obtaining adequate supplies of quality water is a problem in many rural areas. Wells often produce water of low quality; therefore, water is frequently hauled for rural domestic use. Rural public water systems have been proposed; but costs are usually prohibitive, because of the low population per mile.

Currently irrigation has been considered a poor investment, but recent world demands for food and fiber has increased prices for farm products.

Map 24.--Ground Water Quality of Deep Aquifers, Blackwater-Lamine River Basin
Missouri



Source: Missouri Department of Natural Resources, Division of Research and Technical Information.

Proper irrigation could supply some of the future demand. In most areas wells cannot supply an adequate quantity of water, so surface sources would need to be developed to meet this need.

2. Water Quality

The source of pollutants in streams includes discharges from land-effluents from municipal, industrial and individual waste disposal systems and agriculturally related wastes.

A study conducted in 1973 indicated, that with a few exceptions, treatment plants are functioning adequately. 1/ Samples were taken above and below the point where effluent enters the stream.

All stations below the junction of Clear Fork and Blackwater River were void of detectable coliform bacterial contamination. This was probably caused by Blackwater River dilution. At the station near the junction of

1/ Results from this study, conducted by Dr. John Belche, Missouri State University, Warrensburg.

Post Oak Creek and Blackwater River the bacteria count was reported the highest in the basin. The accumulation of bacteria from Chilhowee, Centerview, and Warrensburg may have been a factor. The Blackwater River showed no significant difference between upstream and downstream values for carbon dioxide, alkalinities, detergents, and total bacteria. Dissolved oxygen content was decreased below Concordia and Houstonia in Panther Creek and Buffalo Creek respectively.

Streams in the Lamine River Subbasin had high levels of nitrogen, phosphorous and bacterial levels near the entry points of the treatment systems but dilution effect downstream reduced these values to within acceptable limits. The most persistent problem with effluent from waste treatment plants is the high nitrogen, phosphate and coliform bacteria levels.

Sources of agriculturally related pollutants are soil erosion, applied plant nutrients, pesticides, and organic wastes from animals. The ranking of agricultural potential sources of pollution for the Blackwater and Lamine Subbasins is above average in relation to other subbasins in the state (Table 58).

Table 58.--Ranking of Agricultural Pollution Factors, Blackwater-Lamine River Basin, Missouri 1/

Item	Subbasin			
	Blackwater		Lamine	
	Total	Rank 2/	Total	Rank 2/
Tons of nitrogen applied	11,576	9	6,572	14
Tons of nitrogen per square mile	7.6	8	5.9	21
Tons of phosphate applied	5,715	11	3,659	17
Tons of phosphate per square mile	3.8	22	3.3	25
Number of cattle	163,501	10	98,900	15
Number of cattle per square mile	108	5	89	16
Number of cattlemen feeding:				
100 - 250 cattle annually	67	7	47	10
251 - 500 cattle annually	24	4	11	9
500 cattle or more	3	12	3	11
Number of cattle fed per square mile	15	8	13	10
Number of hogs	196,990	6	93,553	11
Number of hogs per square mile	130	7	85	18
Number of units of poultry	355,768	16	469,630	12
Number of units of poultry per square mile	235	14	424	8

1/ Source: Missouri Agricultural Inventory by Drainage Basins, Agricultural Economics Department, University of Missouri-Columbia for the Missouri Water Pollution Board, WPB-69, February, 1971.

2/ Ranking of these basins in relation to the 52 basins in the State of Missouri

Erosion is highly related to pollution of streams by nitrogen, phosphates and pesticides attached to or associated with eroded soil particles entering streams. Therefore, practices to control soil erosion will not only reduce sediment and turbidity but also reduce chemicals associated with soil particles.

Animal waste increases the level of nitrogen, phosphates and bacteria entering streams. Feedlots are the main source of concentrated pollution from animal wastes. The larger feedlots are now required to construct waste disposal systems. Twenty-two permits had been approved for operation as of 1975.

A natural source of contamination are 19 salt springs in Saline County and three others in adjoining counties. The concentration of these springs results in the Blackwater River having a higher natural mineral content than any other stream in the state. These springs flow from bedrock of Sedalia dolomitic limestone, Mississippian age. The salinity of these springs is a result of connate water being gradually flushed out of the enclosing rocks by precipitation. The discharge of these springs average about 174,000 gallons of mineralized water each day. The dissolved mineral content of spring water increases as the discharge of the spring declines seasonally. Blue Lick Spring is the largest, and the combined discharge of it and two nearby springs and the Upper Blue Lick Spring is about 84,000 gallons per day. The dissolved solids content of Blue Lick Spring is 14,600 parts per million.

The chemical analysis of water from three of the larger mineralized springs in Saline and Cooper Counties shows the amount of mineral discharged (Table 59).

Table 59.--Chemical Analysis of Springs, Blackwater-Lamine River Basin, Missouri 1/

Spring	Calcium	Magnesium	Sodium	Bicarbonate	SO4 Sulfate	Chloride	Dissolved Solids	Hardness as $CaCo_3$: Calcium Magnesium	Hardness as $CaCo_3$: Non-Carbonate
Choteau	390	137	1,970	316	376	3,860	7,410	1,540	1,280
Elk Lick	267	105	1,360	304	284	2,520	4,740	1,100	850
Sweet	224	100	740	246	112	1,500	2,900	969	- -
Upper Blue Lick	1,120	432	7,000	212	150	13,300	23,400	4,580	4,400

1/ Data in Milligrams per liter

Another characteristic of the springs in this area is that they emit hydrogen sulfide gas. These mineralized springs are usually not pleasant to visit because of the odors and because the mineralized water generally kills the vegetation in the vicinity. However, they are considered a local geological phenomena because of the plants and animals found that have adapted to the high mineral contents.

WILDLIFE

Problems identified by the Missouri River Comprehensive Framework Study of the Lower Missouri River Tributary Subbasin include: (1) habitat loss due to land conversion practices, (2) inadequate land use practices, (3) channelization of streams and the subsequent loss of stream side vegetation and drainage of wetlands, and (4) lack of access to existing wildlife populations.

Although not abundant, wetlands and waterfowl habitat are primarily oxbow and cutoff lakes, frequently flooded forest lands, and a 1200 acre complex of accreted flood plain between the Johnson-Pettis County line and Highway 127 at Sweet Springs. Oxbow and cutoff lakes are high value wetlands needing preservation and protection from accelerated sedimentation. These areas are wet complexes offering opportunities for management and development. Flooded forest lands provide varying wildlife values and are almost always an environmentally desirable feature. Efforts are needed so that management and protection is provided for these forested flood plains.

Suburban growth in the western part of the basin has not decreased habitat for either woodland or openland wildlife, but it has increased accessibility problems. More people congregating in an area usually results in more lands being closed to hunters. This accessibility problem is expected to increase in future years. As built-up areas continue to expand, habitat will decline.

Comparisons of hunting demand with potential supplies show 179,500 hunting-trips idle capacity for the present wildlife resources (Table 60). The harvesting of some species--quail, squirrel, and waterfowl-- is probably at or approaching what the resource can presently provide. The estimated potential for quail, squirrel and waterfowl combined is 46,000 hunting-trips annually. In the future, deer can provide twice the present hunting recreation if the present management plans for developing the resource are implemented.

Deer, quail, squirrel and waterfowl are the traditional game species having the most sporting appeal. With harvest of these species at or approaching a desirable level, most of the idle capacity is for those species having less sporting appeal, i.e., rabbit, dove, and "other" small game. "Other" small game includes woodcock, crow, groundhog, raccoon and coyote for both chase and harvest. Many of these species can with-stand an increase in hunting pressure.

Much of the wildlife is produced on private lands. Providing increased hunting on private lands will continue to be a problem. Opportunities to improve hunting access on private lands can be visualized but continued efforts will be necessary. The opportunities include education, public relations, and a satisfactory economic return on landowner investments.

Closely interwoven with the need for increased access to wildlife resources is the problem of protecting and improving habitat conditions. Efforts to solve one should consider solutions to the other problem also.

Table 60.--Hunting Demand, Potential and Needs, Blackwater-Lamine River Basin, Missouri

	1970	1980	2000	2020
Total Hunting Demand 1/	300,500	342,000	425,000	511,000
	- - - - - - - - hunting-trips - - - - - - - -			
Present Use: 2/				
Deer	20,500			
Turkey	3/			
Waterfowl	12,000			
Quail	52,000			
Rabbit	45,000			
Squirrel	40,000			
Dove	16,500			
Other small game	41,000			
Total	227,000	227,000 3/	227,000	227,000
Estimated Potential of Present Resource: 4/				
Deer	41,500			
Turkey	3/			
Waterfowl	15,000			
Quail	75,000			
Rabbit	100,000			
Squirrel	60,000			
Dove	33,000			
Other small game	82,000			
Total	406,500	406,500 5/	406,500	406,500
Idle Capacity of Present Resource (Capacity Minus Use)	179,500	- - - -	- - - -	- - - -
Needs (hunter days):				
Without use of present potential (demand minus total present use)	73,500	115,000	198,000	284,000
With use of present potential	-106,000	-64,500	18,500	104,000

1/ Outdoor Recreation Demand, Needs and Opportunities for Blackwater-Lamine River Basin Study made 1973-74.

2/ Source of present use information except deer and turkey was estimated from results of Post-Season Small Game Harvest Mail Survey, Frank W. Sampson. Missouri Department of Conservation.

3/ Turkey are just being established into the area and their use and potential use is not estimated in this report although future looks bright.

4/ Conservative estimates assuming: (a) land open for public use; (b) present carrying capacity; (c) hunter preference for various species; and (d) present success standards.

5/ Present total projected for future years.

Land use adjustments are needed to benefit wildlife. The desired land use for two terrestrial wildlife groups includes the decrease of grass and legumes and the increase in forest land (Table 61). Both subbasins have good land uses for openland wildlife, but woodland wildlife is limited because of limited forest land areas.

Table 61.--Land Use Relations for Openland and Woodland Wildlife, Blackwater-Lamine River Basin, Missouri

Subbasin	Grains and seed crops	Grass and legumes	Forest	Idle
	- - - - - - - - - - - - - percent	- - - - - - - - - - - -		
Present				
Blackwater	32	51	15	2
Lamine	25	50	24	1
Desired Distribution				
Openland wildlife	40-60	20-40	10-25	5-15
Woodland wildlife	- - - 10 - 30	- - -	50-70	10-20

Woodland wildlife can be improved by increasing the amount of woodlands. Other conditions including improved grazing of woodland, fall tillage and distribution of land uses also have a bearing on wildlife habitat.

Land use adjustments needed for wildlife are feasible since present land use includes 19,000 acres of croplands on Class VI and VII lands and 73,500 acres on Class IV lands (Table 62). Pasturelands are associated with 51,300 acres of Class VI and VII lands, while 85,300 pastured acres is on Class IV lands. Efforts directed to needed land use changes would be more successful on these classes of lands since Class IV, VI and VII lands are marginal for cropping. The best use of these lands are for forage or wood production. Approximately 125,000 acres of these lands have forest site indexes of 60 feet or higher. Well managed forest lands on these sites are competitive with pastures, although return on investment is long term. If the 125,000 acres were converted to forest, the increase of forest in the Lamine Subbasin would be 49,000 acres and in the Blackwater Subbasin 76,000 acres. The remaining 105,000 acres would not provide much wood production, so 85,000 acres could be effectively converted to native grass forage systems. On these sites native grass systems are compatible with management of tame pasture. Cropland would be reduced 93,500 acres or 11.5 percent; pasturelands would be decreased 31,650 acres or 7.5 percent and forest lands would increase 125,000 acres or 42 percent by these conversions.

Shooting preserves and fee hunting areas for small and big game have a high potential for success for a large part of the basin. 1/ This presents opportunities in which some hunting demands can be satisfied, the landowner receives monetary returns for needed land and capital investments.

1/ Appraisals of Outdoor Recreation Potentials, for Johnson, Lafayette, Pettis, Saline, Cooper and Morgan Counties, Missouri 1971.

Table 62.--Land Use Changes for Potential Wildlife Enhancement, Blackwater-Lamine River Basin, Missouri

Present	Blackwater				Lamine			
	Cropland				Cropland			
	Grain and seed	Forage crops	Pasture	Forest land	Grain and seed	Forage crops	Pasture	Forest land
Class I, II, III	275,827	189,107	155,182	70,687	193,483	66,150	131,498	55,051
IV	7,422	32,904	44,096	19,430	15,725	17,345	41,218	29,650
VI, VII	2,482	14,251	31,855	50,597	1,693	1,694	19,447	72,272
	285,731	236,162			210,901	85,189		
TOTAL	521,893		231,133	140,714	296,090		192,163	156,973
Proposed changes	-57,049		-19,175	+76,224	-36,478		-12,478	+48,935
Total future	464,844		211,958	216,938	259,633		179,685	205,908
Percent change	-10.9		- 8.3	+54.2	-12.3		- 6.5	+31.2

56,800 acres or 27 percent of the Blackwater and 27,884 or 16 percent of Lamine future pasture could be effectively used in warm season native grass forage. This acreage would be Class IV, VI, and VII land of low forest land site potential.

Wildlife areas that are publicly owned and managed also offer opportunities for solving wildlife needs. Public lands can augment wildlife produced on private lands and fulfill multi-purpose needs. The increasing interest and demands for hiking, nature study and consumptive wildlife uses can be accomplished on land providing hunting recreation. Such areas provide natural or semi-natural areas for research and education. Hunting can be more effectively managed and wildlife lands can be managed more intensively to increase wildlife carrying capacities. Also, on lands not capable of supporting agricultural enterprises, the public interest is better served when such lands are used less "intensively". In its "Design for Conservation" plans, the Missouri Department of Conservation indicates a high priority for public hunting opportunities and nature enjoyment in this part of the state. Additional facilities are proposed by purchasing, or leasing easements from willing landowners. The objective is to have at least 2000 acres available for public use within easy reach of area residents.

FISH

Fishing problems identified in the Lower Missouri River Subbasin by the Missouri River Basin Comprehensive Framework Plan include the following: 1) Pollution of fishing waters and the difficulty of providing proper water quality, 2) Sediment, 3) Inadequate access to streams and reservoirs, 4) Shortage of facilities, 5) Channelization of streams. Specific problems in the Blackwater-Lamine River Basin are within these outlined problem areas. In terms of magnitude, the dominant problems are inadequate access to existing resources in combination with a long-term shortage of fishing opportunities. At present, 1970, there is a fishing demand of almost 750,000 fisherman-trips annually (Table 63). The estimated demand being satisfied in the basin is 272,600 fisherman-trips. Of this, 46,400 is being provided by streams and 226,150 by lakes and ponds. 1/

Lakes and ponds have a capacity of 362,000 fisherman-trips. The 480 miles of streams have a capacity of 65,000 fisherman-trips. The basin total is 427,000 fisherman-trips. The difference between total capacity of the resource and the present use of 272,600 fisherman-trips shows an idle capacity of 154,400 fisherman-trips. Part of the idle capacity is the result of inadequate access to the existing resources, and this condition is expected to continue.

Another fishing problem is water quality. Pollution sources are of two categories. The most obvious is municipal waste associated with urban and built-up areas. Although this problem is serious, it affects a small part of the stream system. Municipal pollution from the city of Warrensburg includes Lower Post Oak Creek where fish kills have occurred and Bear Creek, a tributary to the Upper Blackwater River. Twenty-five miles of these 2 streams have polluted water. The city of Sedalia contributes sewage effluent to a 2-mile long tributary of Muddy Creek northeast of Sedalia. A 2-mile tributary (of Flat Creek) southeast of Sedalia is affected by sewage disposal systems. Four thousand fish were killed in 1971 in Flat Creek below this tributary. Except for special conditions Flat Creek is generally not

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1/ Outdoor Recreation Demand, Needs, and Opportunities for Blackwater-Lamine River Basin Study. 1973-74.

Table 63.--Fishing Needs, Blackwater-Lamine River Basin, Missouri

	Fisherman-days			
	1970	1980	2000	2020
Demand	747,600	850,800	1,060,000	1,271,000
Present and projected use of present resources	272,600	272,600	272,600	272,600
Capacity of present resource 1/	427,000	427,000	427,000	427,000
Idle capacity of present resource (capacity-use)	154,400	- -	- -	- -
Capacity of present resource if problems are solved 2/	789,000	789,000	789,000	789,000
NEEDS				
--Without problems solved	475,000	578,200	785,400	998,400
--With problems solved	42,400	61,800	271,000	482,000
NEEDS (public acres)	acres			
--Without problems solved 1/	9,500	11,564	15,705	19,967
--With problems solved 2/	- -	617	2,688	4,819

1/ Projecting 50 fisherman-days per surface acre as capacity.
2/ Projecting 100 fisherman-days per surface acre as capacity.

seriously affected because the sewage is quickly diluted.

A second category of pollution includes non-point sediment in streams. This problem is not as important in the Lamine as in the Blackwater Subbasin. Sediment pollution rarely results in any spectacular fish kills, but it does lower the waters fish carrying capacity.

Associated closely with the effects of pollution and sediment in streams is the lack of management of most impoundments. Most waters are stocked, but little fishery management considerations are given. Improved management of farm ponds and lakes could substantially increase fishing potentials.

In many of the larger impoundments owners do not apply available technology. Also, many lakes are multiple-purpose and are managed for water supplies. Multiple-purpose lakes have a more complicated management problem.

Channelization affects stream fish production. In 1970, samples made by the Missouri Department of Conservation on the Blackwater River compared a newly channelized section, a moderately channelized section and an unchannelized section of stream. Fish populations were higher on the unchannelized sections. The Blackwater Subbasin has a considerable amount of unstable channelized sections. These occur in the Upper Blackwater River, on several miles in Davis Creek, and for several more miles on Salt Creek in Saline County.

Fishing potential is lost because of the inaccessibility of the existing water resources (Table 63). Some of these resources are the estimated 5300 acres of farm ponds that are less than five acres in size. Most of these are in private ownership. An increased economic incentive is needed in order for private ownership to make this resource available to the public.

The unsatisfied demand (Table 63), along with the high rating for fishing water development 1/, makes the development of income producing enterprises for the recreational fishing market a viable potential. Operations of fish-outs and fish ponds are successful enterprises where sound technical and business management sales practices are used.

The 1970 estimated demands for fishing could be realized if water quality problems and access to existing water resources could be solved. However, increased fishing demands, apparent infeasibility of complete solutions to improvement in water quality, and inaccessibility stress the need for more fishing resources and facilities. Since streams do not have a high potential, lakes or flat water resources are needed. The smaller, 50 to 150 acre, public impoundments developed and managed for fishing are desirable for providing additional fishing opportunities.

ENVIRONMENTAL CONSIDERATIONS

1. Environmental Corridors

The ecological environment of streams and the diversity of surrounding land needs to be preserved and maintained. Past abuse to the land and water caused by channel work, land conversion, intensive land use and neglect have destroyed some of the scenic and environmentally desirable stream corridors.

To determine where the problems and needs are located, a qualitative rating system for environmental corridors was developed to compare individual stream segments. This system was derived from Quantitative Comparison of Some Aesthetic Factors Among Rivers, by Luna Leopold, U.S.G.S. and modified for midwestern conditions. Basic data, including forest land, recreational developments, fish and wildlife classified areas, water quality, stream bottom and streambank conditions, etc., were used to evaluate the selected corridors.

The individual corridors were evaluated to compare environmental quality. The corridors are the remaining land and water areas that have not been significantly altered by man. The timber along streams offer recreational values, promote scenic beauty and protect important ecosystems.

The corridors were evaluated in three broad areas; Physical Factors/Biological and Water Quality/and Human Use and Interest (Table 64). Within these areas, 24 factors were evaluated on each segment. A numerical rating was used ranging from one to five; one being very poor and five being excellent environmental conditions (Map 19).

The results showed that overall the value of the Blackwater Subbasin is less than average in the state compared to other streams of similar environmental nature; whereas, the Lamine Subbasin is above average. The Blackwater Subbasin has 5 corridor segments (about 60 miles) with an average or above average environmental quality value. However, the Lamine Subbasin has 17 corridor segments (about 160 miles) with an average or above quality value.

1/ Appraisals of Potentials for Outdoor Recreation Developments for Johnson, Lafayette, Pettis, Saline, Cooper and Morgan Counties, Missouri. 1971.

Table 64.--High Value Environmental Corridors, Blackwater-Lamine River Basin, Missouri

Description	Reach: Miles	Reach: Acres	Aesthetic factors: Physical	Aesthetic factors: Biological	Aesthetic factors: Human interest	Aesthetic factors: Total
			- - - - - - - -	rating 1/	- - - - - - - -	
Blackwater Subbasin						
Clear Creek	17	13,500	3.8	3.4	3.7	3.5
Lamine Subbasin						
Lamine River reaches	54	32,854				
Segment 1 - 4			3.0	3.7	2.9	3.2
			3.1	3.7	3.2	3.3
			2.8	3.9	3.3	3.3
			3.0	3.4	3.3	3.3
Clear Creek	4	1,600	3.3	4.2	2.8	3.3
Richland Creek	8	6,480	3.7	4.1	2.6	3.3
Haw Creek	8	6,480	3.2	4.0	2.9	3.3
Heaths Creek	9	6,024	3.5	4.0	2.5	3.2
Otter Creek	8	4,270	3.7	3.7	2.7	3.2
Subtotal	91	57,708				
Total	108	71,208				

1/ 5.0 = Best environmental conditions 3.0 = Average 1.0 = Poor

The highest value corridors include the upper reach of Clear Creek in the Blackwater Subbasin; the Lamine River and the lower reaches of Haw, Heaths, Clear, Otter, and Richland Creeks in the Lamine Subbasin. Usually the physical factors cannot be changed. But the biological, human use and interest factors can be altered through increased awareness and intensified management. Sixteen segments in the Blackwater Subbasin and 14 in the Lamine Subbasin were rated below average (Table 65). Generally, the existing recreational areas are located within the corridors. Most future recreational developments are expected to be located in or near the corridors.

Table 65.--Environmental Corridor Ratings, Blackwater-Lamine River Basin, Missouri

Description	Reaches: Number	Reaches: Miles	Reaches: Acres
Blackwater Subbasin			
3.0 - 3.5 average or above	5	60	65,000
2.5 - 2.9 below average	12	89	100,000
Under 2.5 poor	4	55	51,000
Subtotal	21	204	216,000
Lamine Subbasin			
3.0 - 3.5 average or above	17	160	101,000
2.5 - 2.9 below average	12	132	112,000
Under 2.5 poor	2	30	22,000
Subtotal	31	322	235,000
Total	52	526	451,000

The basic concept of a good environmental corridor is a balanced distribution of vegetative landscapes useful for scenic, aesthetic, recreation, fish, and wildlife resources. Their development will require a new set of values by planners, landowners and the public. To be successful, priorities will be required on the quantity of land, the public access needed and the land use priorities.

The establishment, preservation, enhancement or management of higher rated corridors should have priority. This involves 57,708 acres or 89 miles of the Lamine Subbasin, and 12,800 acres or 10 miles of the Blackwater Subbasin.

Another environmental corridor which needs to be considered for potential development is a segment of the mainstem of Blackwater River from the Johnson-Pettis County line to the mouth of Blackwater River. These segments have a lower environmental rating and should have somewhat lower priority for establishment. They involved 54,426 acres and 52.2 miles of river channel. Some lands in the upper portion of this corridor have been purchased by the Missouri Department of Conservation. The State of Missouri has an active land acquisition program going in this area for each usage.

2. Archeological and Historical

The location of all of the historical and archeological resources in the basin have not been surveyed or cataloged. Known resources are described in the environmental setting section. Any action requiring modification of the land may impact archeological and historical resources. Since many historical resources are located in towns or in topographically high areas, the impact of water resource project development is not expected to be significant. Since both archeological sites and project development works occupy similar topographic areas, earthmoving may have impacts on archeological resources.

During project development, and prior to project formulation, surveys are needed to inventory and determine the location and significance of archeological resources. The results of these surveys should be used to avoid significant impacts on archeological resources or to provide information relative to the salvage or preservation of these resources.

If important sites are discovered within the basin, they could provide the focus for archeological interpretive centers. Other than the Lyman Archeological Research Center operated by the University of Missouri, near Van Meter State Park, no visitor centers or parks emphasizing archeology are found within the basin.

Visiting farms, nature trails, horseback riding and canoeing provide delightful experiences for young and old.

Beautiful vistas and new adventures await those who enjoy the out-of-doors.

CHAPTER IV

Future Alternative Land Uses and Resource Development for Economic Objectives

FUTURE ALTERNATIVE LAND USES AND RESOURCE DEVELOPMENT FOR ECONOMIC OBJECTIVES

The two basic objectives for water and land resource planning are to enhance economic development by increasing the efficiency and production of goods and services and to enhance the environmental quality of natural resources. Land and water can sometimes be used and developed for either objective with no serious conflicts. In many cases, however, the use and development of land and water resources for one objective will adversely affect the other. This chapter explores some of the broad implications of future major land use changes and potential water resource development.

PROJECTED CONDITIONS FOR YEARS 1980, 2000, AND 2020 WITHOUT RESOURCE DEVELOPMENT

Most of the land in the basin is owned and managed by farmers. Land use is therefore largely determined by farmers' decisions in pursuit of their goals. Their goal is to organize their resources in such a way that they will produce those commodities in demand and in doing so increase their incomes. The future demand for food and fiber from the basin was estimated and presented in Chapter II. These estimates are used as targets for assessing future production from the basin soils, the expected land use shifts, and net income and erosion associated with these levels of production (Table 66). These projections are based on the assumption that the basin will continue to export agriculture commodities for national demand.

Table 66.--Projected Food and Fiber Requirements, Blackwater-Lamine River Basin, Missouri

Product	Unit	Year 1970	1980	2000	2020
Agricultural					
All hay	Mill. feed units 1/	211	245	298	418
Corn	Mill. bu.	20.08	27.62	31.85	36.52
Oats	Mill. bu.	.72	.35	.16	.09
Sorghum	Mill. bu.	2.13	5.96	9.47	13.39
Soybeans	Mill. bu.	4.06	5.89	7.48	9.19
Wheat	Mill. bu.	2.73	3.66	3.93	3.98
Forest					
Fuelwood	Mill. cu. ft.	.25	.25	.25	.25
Pulpwood	Mill. cu. ft.	.75	2.75	6.45	8.80
Sawlogs	Mill. cu. ft.	.90	2.00	1.70	.75

1/ 770 feed units equal about 1 ton of hay.

A minimum cost linear programming model was used to project future levels of these variables in the basin. This model estimates how land and other resources could be used to produce the future agricultural requirements at minimum cost. Implicit in the model is the assumption that economic incentives will induce farmers to shift land uses and combine other inputs with land in a way that will produce the projected quantities of agricultural products at the lowest cost.

Some constraints were imposed to more realistically reflect farmers'

present goals, organization, and method of farming. For example, it was assumed that at least 25 percent of the crops and 50 percent of the permanent pasture now grown on a particular soil will remain on that soil group by the year 2000, and at least 10 percent of the land presently idle will remain idle. Based on past farming practices, it was also assumed that no more than 75 percent of the forest land on a given soil group would be cleared and shifted to crops or pastures. The annual cost was estimated to be $9.50 per acre. This amounts to a cost of clearing of $119 per acre capitalized at 8 percent interest.

For the purpose of comparison, agricultural production, net income and erosion were also estimated for constant land use. The constant land use condition assumes that all agricultural and forest land uses will remain the same as in the base year, 1970, except for the reduction due to land shifting into nonagricultural uses. An analysis using these two sets of assumptions gives some insight into the capacity of the basin's resources to produce the expected share of national products in the future. Increased production for the constant land use condition is a result of expected increases in crop and pasture yields due to the adoption of improved technology. Increased production for the minimum cost land use condition includes the additional production possible from shifting agricultural land to the most productive uses as well as from clearing forest land when it is the most economical way of meeting the demand for agricultural products. No attempt was made to meet the demand for forest products in the model.

1. Food and Fiber Production

The percent of the projected production requirements that could be met with constant and minimum cost land use is presented in (Table 67). If land uses remained constant, the gap between agricultural production requirements and production would widen in future years. If land use shifts occur and forest land continues to be cleared as predicted by the minimum cost model, agricultural production requirements could be met for the years 1980 and 2000, but hay and pasture production would be reduced to 75 percent required by year 2020.

The supply of wood products in 1970 was greater than the demand. This relationship is expected to reverse, however, by year 1980. If land use remains constant and no additional land is cleared and shifted to agricultural uses, only 88 percent of the projected wood production requirement would be met. The gap between production and requirements would widen and by 2020 only 61 percent of the projected wood requirements would be met (Table 67). The gap between projected wood requirements and production would be even greater if projected minimum cost land use conditions prevail. Reduced acreage in forests would result in only 48 percent of the wood requirements being met in 1980 and only 10 percent by the year 2020.

2. Land Use Shifts

Several land use shifts would be required to meet the projected agricultural requirements as shown in (Table 67). In general, tilled cropland acreage would increase, hay and pasture acreage would decrease, and additional forest land would be cleared (Figures 28 and 29).

Table 67.--Percent of Projected Food and Fiber Production Requirements Met Without Resource Development for Constant and Minimum Land Use, Blackwater-Lamine River Basin, Missouri

Item and Condition	Year 1970	1980	2000	2020
	- - - - - - -	percent	- - - - - - -	
Percent of projected production requirements met:				
Crops				
Constant land use 1/	100	86	75	63
Minimum cost land use 1/	100	100	100	100
Pasture and hay				
Constant land use 1/	100	114	99	73
Minimum cost land use 1/	100	100	100	75
Wood products				
Constant land use 1/	100	88	69	61
Minimum cost land use 1/	100	48	20	10

1/ Percent of projected production requirements met for a given year.

If demand for agricultural products presses resource capability from the area as indicated by the projections for year 2020, up to 40 percent of the total forest and 48 percent of commercial forest might be cleared and used for crop and forage production. A total of 144,000 acres of forest land, of which 56,000 is bottom land, would be cleared. This would reduce the bottom land area in forests from the present 27 percent to about 3 percent. The upland area in forests would be reduced from 17 percent to 10 percent and the total area of the basin would decrease from 19 percent forested to 9 percent. These projections are based on the assumptions that monetary incentives for producing the agricultural product requirements would be greater than incentives for meeting wood products or environmental goals.

3. Net Agricultural Income

Net returns to agriculture would increase more if minimum cost land uses occurred than if land use remained constant. Minimum cost land use refers to the most efficient means of producing the projected basin share of national requirements for agricultural production, as indicated by a least cost linear programming analysis. Net returns would rise from $27,100,000 in 1970 to $40,100,000 in 2020 if land use remained constant (Table 68). If the minimum land use shifts occurred, net income would more than double the 1970 level and reach $60,800,000 by the year 2020. The increase in net returns for the constant land use is predicated on adopting more efficient technology while the increase for the minimum cost land use includes additional gain from shifting land uses and clearing forest land.

4. Soil Erosion

Soil erosion is closely related to land use, particularly upland use. For the purpose of this analysis it was assumed that the present level of conservation practices would remain about constant for a given use of land.

Figure 28.--Projected Minimum Cost Land Use, Without Resource Development Blackwater-Lamine River Basin, Missouri

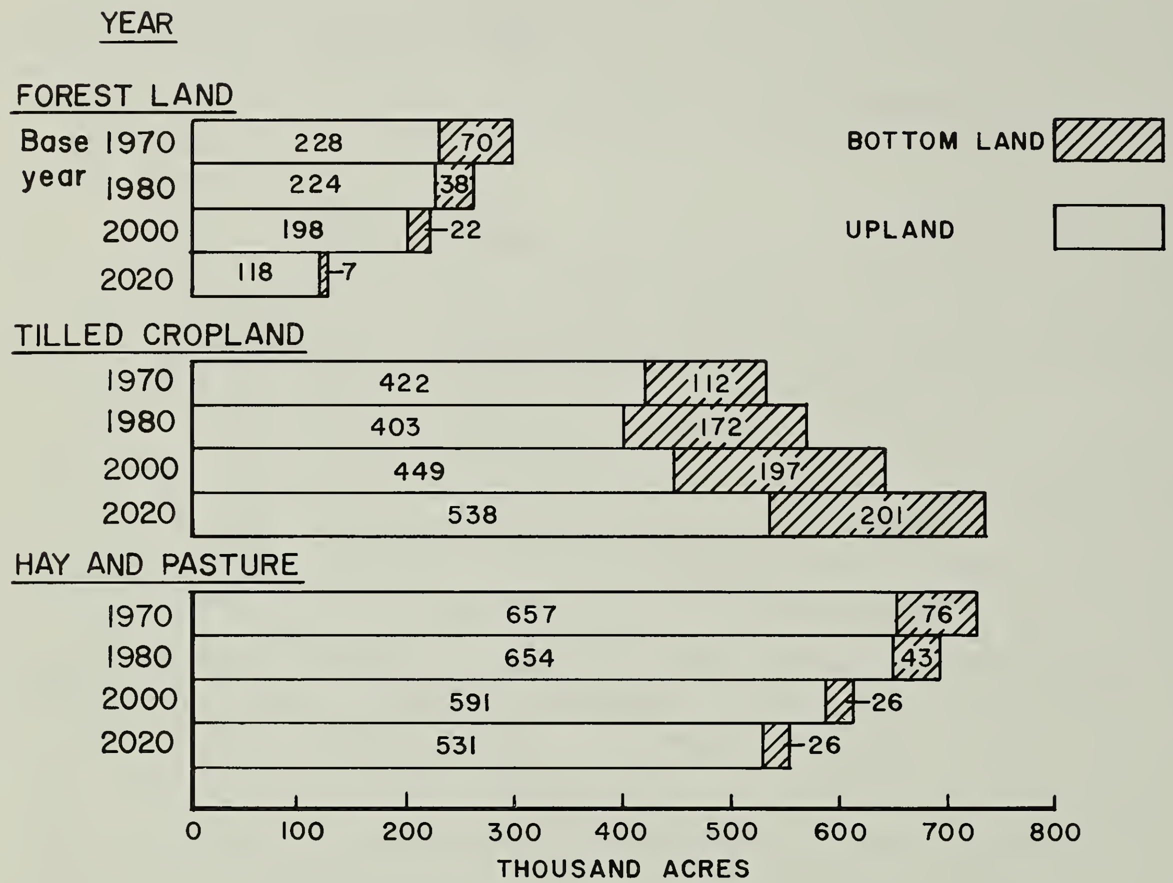


Figure 29.--Projected Minimum Cost Clearing of Forest Land Without Resource Development, Blackwater-Lamine River Basin, Missouri

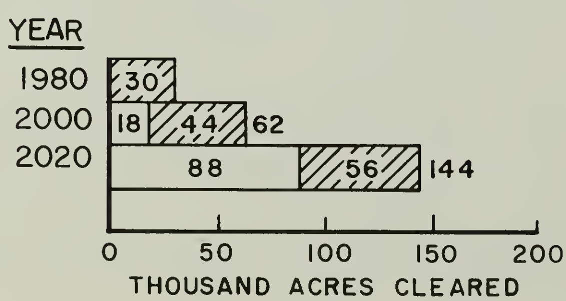


Table 68.--Net Income to Agriculture Without Resource Development for Constant and Minimum Cost Land Use, Blackwater-Lamine River Basin, Missouri

Item	Net agricultural income by year			
	1970	1980	2000	2020
	- - - - - million dollars - - - - - -			
Constant land use	27.1	35.1	38.6	40.1
Minimum cost land use	27.1	40.3	52.4	60.8

The projected levels of erosion therefore reflect land use changes only.

Gross sheet erosion on agricultural and forest lands would increase from 19,600,000 tons to 27,000,000 tons if the minimum cost land use occurs (Table 69). The initial decrease in erosion for the year 1980 is predicated on a reduction in use of erosive uplands and an increase in use of bottom lands for tilled crops as illustrated in Figure 28. In later time periods, more upland soils would be tilled as resources are needed for crop production to meet production requirements. If the erosion control practices remain at the present level, the erosion rate per acre would increase by 50 percent from 12.2 tons to 18.5 tons.

Table 69.--Gross Erosion on Agricultural and Forest Lands Without Resource Development for Constant and Minimum Cost Land Use, Blackwater-Lamine River Basin, Missouri

Item	Unit	Year			
		1970	1980	2000	2020
Constant land use	Mill. tons	19.6	19.2	18.6	17.6
Minimum cost land use	Mill. tons	19.6	16.9	23.1	27.0
Constant land use	Tons/acre	12.2	12.2	12.2	12.2
Minimum cost land use	Tons/acre	12.2	10.7	15.1	18.5

If agricultural and forest land use remains constant the annual erosion rate per acre is also expected to remain constant at 12.2 tons per acre. The gross erosion on all agricultural and forested land might decrease slightly from land use shifts to non-agricultural uses. However, this potential reduction is dependent upon both the new and the replaced agricultural use.

5. Economic and Environmental Tradeoffs

Without further resource development there will be several tradeoffs between economic goals and environmental goals. Net income levels will be higher if farmers change land uses to meet the projected demand for agricultural products than if land use remains constant. By 2020 net income to agriculture could be $20,700,000 greater if land use shifts occur than that attainable with constant land use (Table 70). The increase in income possible through land use shifts must be weighed against environmental goals. Crop production could be 37 percent higher and pasture production 2 percent higher if land use shifts occur. Associated with the 254,000 acre shift in land to tilled cropland would be increased use of pesticides, herbicides, fertilizers and other chemicals. Sheet erosion would also be 9,400,000 tons

Table 70.--Projected Differences in Agricultural Variables for Constant and Minimum Cost Land Use, Blackwater-Lamine River Basin, Missouri

Item	Unit	Minimum cost minus constant land use		
		Year		
		1980	2000	2020
Agricultural production				
Crops	Percent 1/	14	25	37
Hay and pasture	Percent 1/	-14	1	2
Land use				
Tilled cropland	1000 acres	52	140	254
Hay and pasture	1000 acres	-21	-77	-109
Forest land	1000 acres	-30	-62	-144
Net agricultural income	Mill. dollars	5.2	13.8	20.7
Net forest income	Mill. dollars	-.1	-.2	-.2
Gross erosion 2/	Mill. tons	-2.3	4.5	9.4

1/ Difference in percent of agricultural production requirements met.
2/ Positive number indicates increase in erosion.

higher as a result of pasture and forest land shifting into tilled cropland use.

The loss of forest land, particularly in bottom land along the streams and rivers, would lower environmental quality through the reduction in wildlife habitat, scenic landscapes, water quality and reduced recreation potential.

The full changes indicated by the minimum cost land use conditions will probably not be attained because some farmers have environmental and conservation objectives that supersede profit motives. However, lacking public policies for preserving and enhancing environmentally important areas, incentives for land uses which maximize the returns to the landowner will often prevail.

PROJECTED CONDITIONS FOR YEAR 2000 WITH AND WITHOUT FLOOD CONTROL AND DRAINAGE

The following analysis focuses on the effects of public water resource development for the target year 2000. By then, time would allow public resource developments to be constructed and shifts in resource demand and use.

Flood control and drainage are the two major water resource developments considered. The with resource development situation was evaluated for two levels of flood control and drainage; 60 percent and 100 percent. Although the 100 percent levels will probably never be attained, an analysis of these two levels permits a basis for estimating intermediate levels of development.

The analysis assumed that flood control precedes drainage. This does not necessarily mean that a considerable amount of drainage could not be undertaken without flood control. However, the two problems are often

interrelated and it is difficult to determine whether the major problem is from flooding or lack of drainage (Table 50). In many areas, if drainage works were installed, outlets would often be restricted because of backup water from flooding. In these areas some degree of flood control would be necessary for drainage to be completely successful.

The beneficial and adverse effects of public resource development in the year 2000 will depend on several variables that determine the demand for land. All of these variables cannot be accurately predicted. Therefore a range of three different sets of conditions are used to estimate the corresponding range in beneficial and adverse effects of resource development. Each set of conditions assumes a different demand for agricultural products. Consequently, the land use, production, agricultural net income and erosion resulting from each set of conditions will be different. The three conditions include the two used in the previous section, constant and minimum cost land use, plus a third profit maximization land use. A summary of the assumptions regarding the demand for farm products, land use constraints and the criteria used for limiting land use shifts for the three conditions is shown (Table 71).

The major differences in assumptions for the three conditions center around the level of future demand for farm products and how farmers react to price incentives associated with different levels of demand. The constant land use condition assumes farmers will not change the land use even if flood control and drainage occur. Although this assumption is probably not realistic, it permits the evaluation of flood control and drainage benefits for one extreme. The other extreme is the profit maximization land use condition which assumes that each acre of land will be used for the most profitable crop possible whether or not resource development occurs. This set of conditions is not completely realistic because it assumes that the demand for farm products is unlimited and ignores goals other than the profit motive that enter into land use decisions. It does, however, represent the upper extreme in demand for farm products and intensive use of land for agriculture. The production and net income calculations for this set of conditions represent the expected maximum possible with existing technology. Benefits to flood control and drainage are therefore also highest.

The minimum cost set of conditions represents a level of demand and land use shifts that is intermediate between the other two extremes. This set of conditions is used to hold the production of agricultural commodities at the projected level judged most likely to occur while investigating alternative combinations of inputs to meet the projected demand. Thus, this model permits investigating the substitution between resource development and other means of meeting the target demand estimates of agricultural products for the area.

1. Agricultural Production and Demand

The norm used for comparing agricultural production for alternative future land use conditions is the target estimates of demand of "agricultural requirements" as presented in Table 67.

The percent of these requirements met with and without resource development is presented in (Table 72). The production of tilled crops would be less than the projected requirements if land use remained constant, even with

Table 71.--Assumptions and Criteria for Three Sets of Conditions Used in Evaluating Resource Development Potential in Year 2000, Blackwater-Lamine River Basin, Missouri

Item	Assumption and Criteria
Demand for agricultural products:	
Constant	The demand for agricultural products from the basin area will be sufficient to clear national markets at the projected commodity prices.
Minimum cost	The demand for agricultural products, estimated in Table 67 are the quantities that can be marketed from the basin at the projected commodity prices.
Maximum profit	The quantities of agricultural products from the basin will have no affect on national markets. All quantities produced can be sold at the projected commodity prices.
Land use constraints:	
Constant	No change in land use.
Minimum cost	Land will shift to those uses which will minimize costs of production subject to the following constraints: 25 percent of the crops and 50 percent of the pasture on a given Soil Productivity Group (SPG) will remain in that use. Up to 75 percent of the forest land can be cleared at an annual cost of $9.70 per acre.
Maximum profit	Each acre of existing cropland and pasture will shift to the uses which maximize profit. The acreage of forest land cleared is the same as determined by the minimum cost solution for without resource development. This level of clearing remains the same with resource development.

full resource development. The requirements could be met with or without resource development if minimum cost land use adjustments occur. If maximum profit land use prevailed, production of tilled crops would be two and one-half times greater than projected requirements.

The requirements for pasture and hay could be met with either constant or minimum cost land use. However, all pasture and hayland would shift to tilled cropland if maximum profit land use occurred.

A summary is presented of expected shifts in production for upland and bottom land areas for the two levels of resource development (Figure 30). The results of the assumptions made in regard to demand for agricultural products are illustrated. For the constant and maximum profit land use conditions it was assumed that the quantities of agricultural products supplied from the basin would have no effect on national markets and could be sold at

Table 72.--Percent of Projected Agricultural Requirements met With and Without Resource Development for Alternative Conditions for Year 2000, Blackwater-Lamine River Basin, Missouri

Crop and Condition	Percent of projected agricultural requirements produced				
	Without development	With flood control 60	With flood control 100	With flood control and drainage 60	With flood control and drainage 100
	- - - - - - percent - - - - - -				
Constant land use:					
Tilled crops	75	77	79	78	80
Pasture and hay	99	100	101	101	102
Minimum cost land use:					
Tilled crops	100	100	100	100	100
Pasture and hay	100	100	100	100	100
Maximum profit land use:					
Tilled crops	245	247	253	252	255
Pasture and hay	0	0	0	0	0

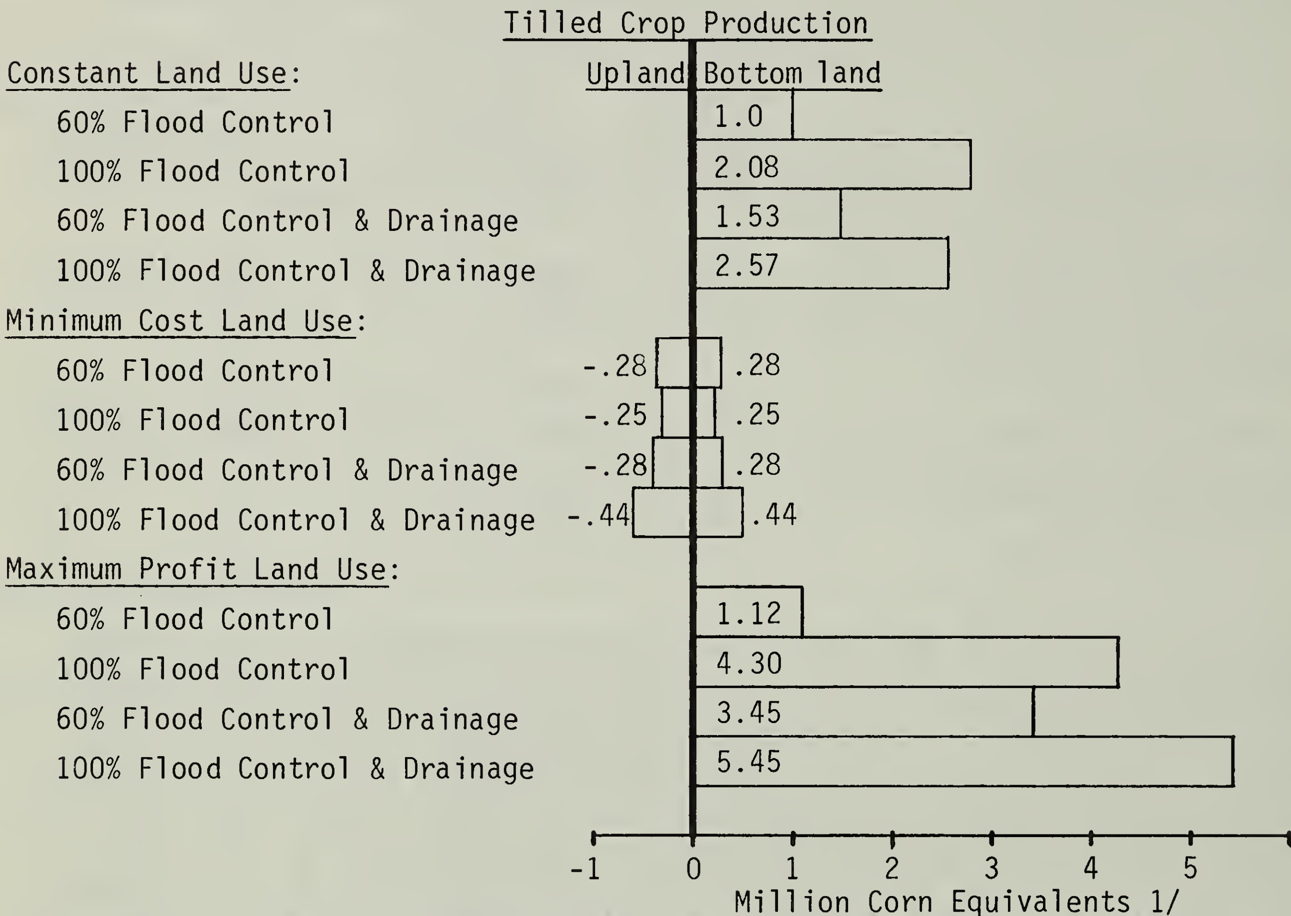
projected prices. For the minimum cost land use, however, it was assumed that total production in the basin would just meet the projected agricultural requirements. Therefore, any increase in production in bottom land areas due to resource development would be offset by decreased production in upland areas. Although in reality the reductions in production to offset increases resulting from resource development may not all occur within this basin, the reduction would have to occur somewhere in the United States for projected commodity prices to be maintained. Thus, the assumptions for the minimum cost conditions provide a theoretical basis for directly measuring the economic and some environmental impacts of meeting a given level of farm production with and without resource development.

Tilled crop production would increase most with resource development if maximum profit land use occurred and least if minimum cost land use adjustments are made. Hay and pasture production in bottom land areas would increase with higher levels of resource development if land use remains constant. If minimum cost conditions prevail, there would be less shifting of hay and pasture production from bottom land to upland areas with higher levels of resource development. At higher levels of resource development a larger proportion of all crops including pasture and hay could be produced in bottom land areas. This would permit meeting the agricultural requirements with less intensive use of upland areas as well as less clearing of forest land.

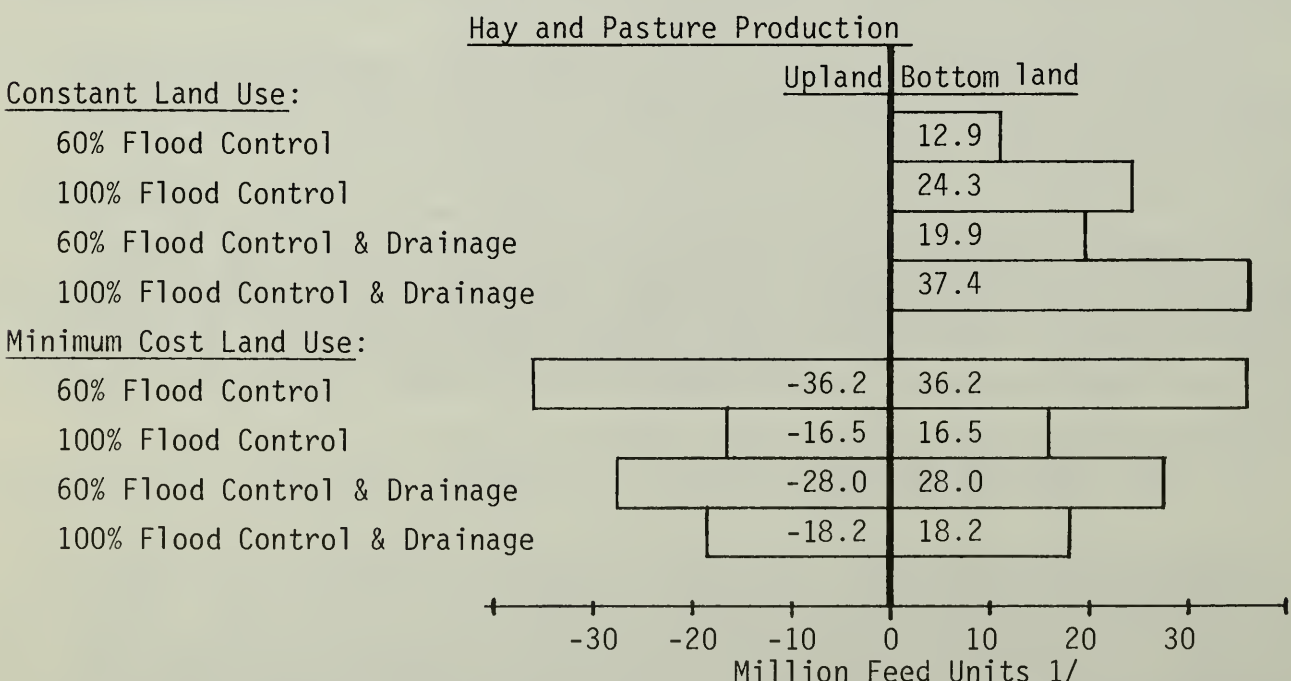
2. Land Use Shifts

The differences in major land uses in the year 2000 for the three conditions without resource development are illustrated in (Figure 31). About 33,600 acres of forested bottom land and 52,800 acres of forested upland would shift to cropland or pasture if minimum cost conditions prevailed. It was assumed that the same amount of forested land would be cleared for the maximum profit condition and all of this land as well as the existing

Figure 30.--Changes in Production With Resource Development for Alternative Conditions, by Upland and Bottom Land Areas for Year 2000, Blackwater-Lamine River Basin, Missouri

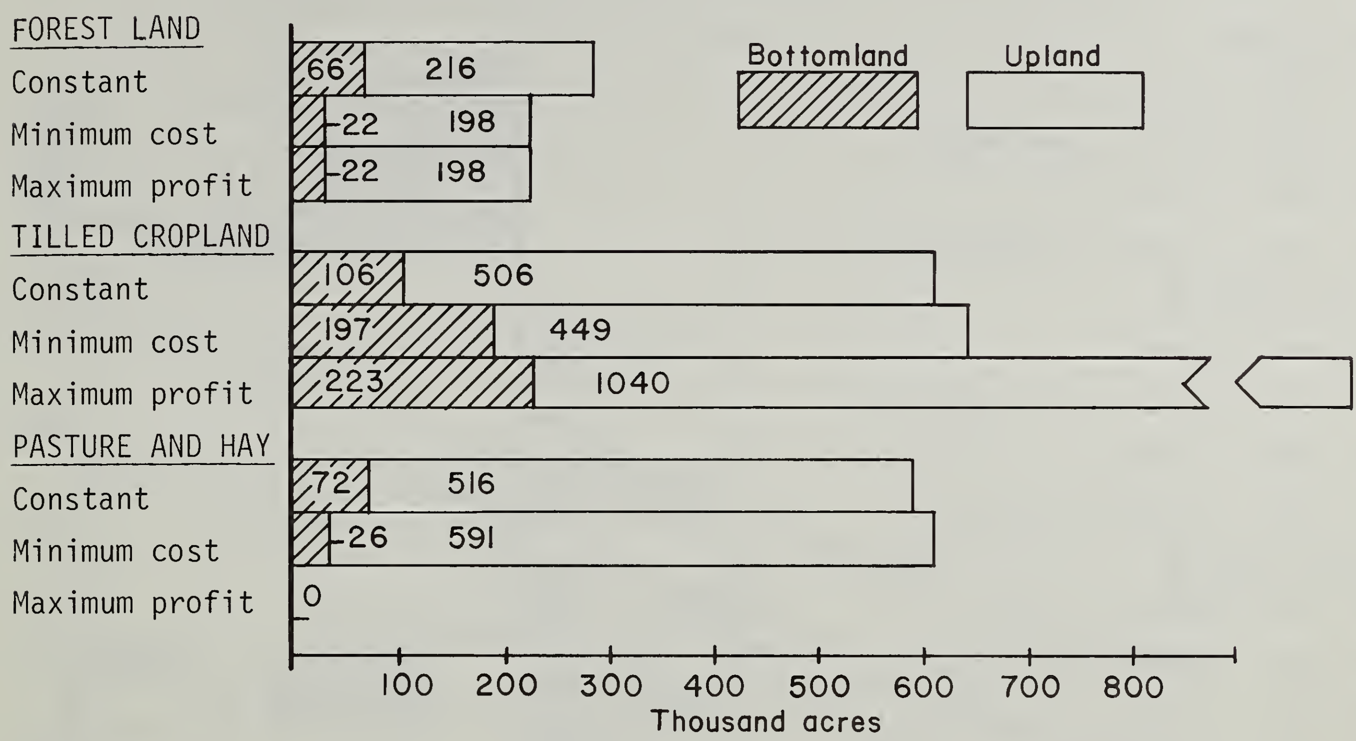


1/ A corn equivalent is the feed value of one bushel of number 2 yellow corn or its equivalent.



1/ The basic feed unit is the feed value of one pound of number 2 yellow corn or its equivalent.

Figure 31.--Land Use Without Resource Development for Alternative Conditions for Year 2000, Blackwater-Lamine River Basin, Missouri

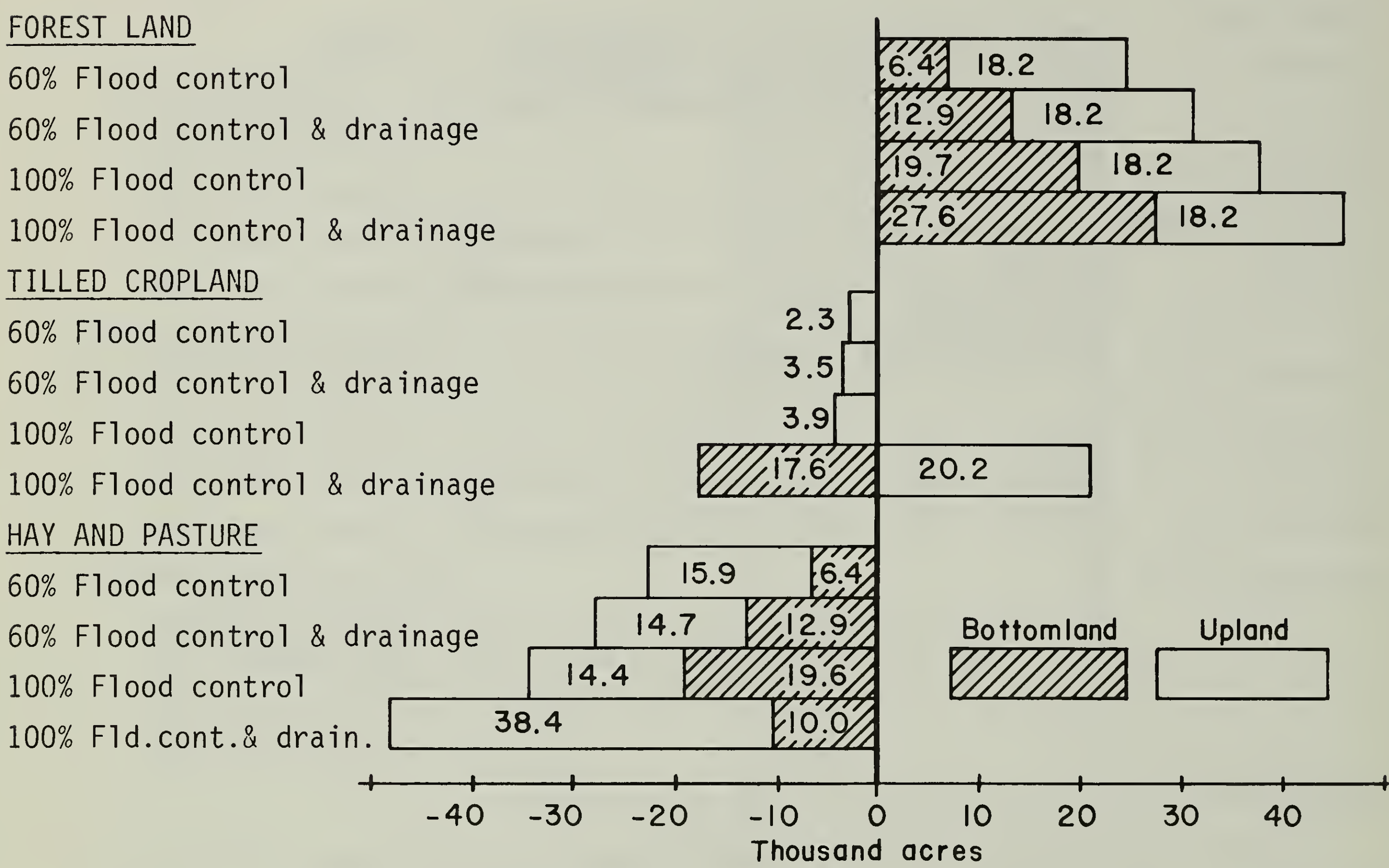


pastureland and hayland would shift to tilled crops.

It was assumed that with development, land use would remain the same as depicted in (Figure 31) for constant and maximum profit conditions. For minimum cost conditions, however, it was assumed that land use would shift with resource development in a manner that produced the agricultural requirements at the lowest costs. These shifts representing the difference between without and with the various levels of flood control and drainage are illustrated in (Figure 32). In general, as resource development occurs more land could remain in forests and less land would be needed for hay and pasture.

The tradeoffs between resource development and clearing of forest land are presented in (Figure 33). If the level of demand for agricultural products projected for the basin is attained at minimum costs, it would be economically feasible to clear up to 44,000 acres of forested bottom land and 18,000 acres of forested upland by the year 2000 if no flood control or drainage occur. The same level of demand could be most economically met by clearing 25,000 acres of bottom land and no upland if full flood control were provided or by clearing 17,000 acres of bottom land if both flood control and full drainage occurred. This demonstrates how increased production through flood control and drainage might substitute for possible production through clearing of bottom land forests. There is no assurance, however, that the substitution will take place within this basin. Instead, flood control and drainage in this basin might substitute for clearing in another basin. The analysis does, however, demonstrate that the demand for agricultural products and levels of flood control and drainage developments can both affect how much forest land is cleared in the region.

Figure 32.--Land Use Changes With Development, Minimum Cost Condition for Year 2000, Blackwater-Lamine River Basin, Missouri



3. Economic Benefits of Resource Development to Agriculture

The primary objective for flood control and drainage is to enhance the economy of the basin. Agriculture is a major sector of the economy and provides employment and income for not only those directly involved in farming but also agriculturally related industries. The future level of agricultural income is therefore an important determinant of the economy.

The future level of agricultural net income will be determined primarily by the demand for agricultural products and the response of farmers to that demand. In general, a low level of demand for agricultural products is implied by the constant land use conditions. The most likely level of demand is associated with the minimum cost land use, and the highest level of demand corresponds to the maximum profit land use.

The estimated level of agricultural income for these alternatives in the year 2000 if no resource development occurs is present in (Table 73). Note that net agricultural income is expected to increase by about $11,000,000 above the 1970 level if land use reamins constant, by $25,000,000 if shifts in land use occur to meet the demand at minimum costs, and by $65,000,000 if each acre of land is used for the most profitable crop. Thus, shifts in land use in response to the demand for agricultural products will be the major factor in raising farm income to the area whether or not resource development takes place.

Figure 33.--Relationship Between Resource Development and Acreage of Cleared Forest Land Required to Meet Projected Agricultural Requirements, Minimum Cost Condition for Year 2000, Blackwater-Lamine River Basin, Missouri

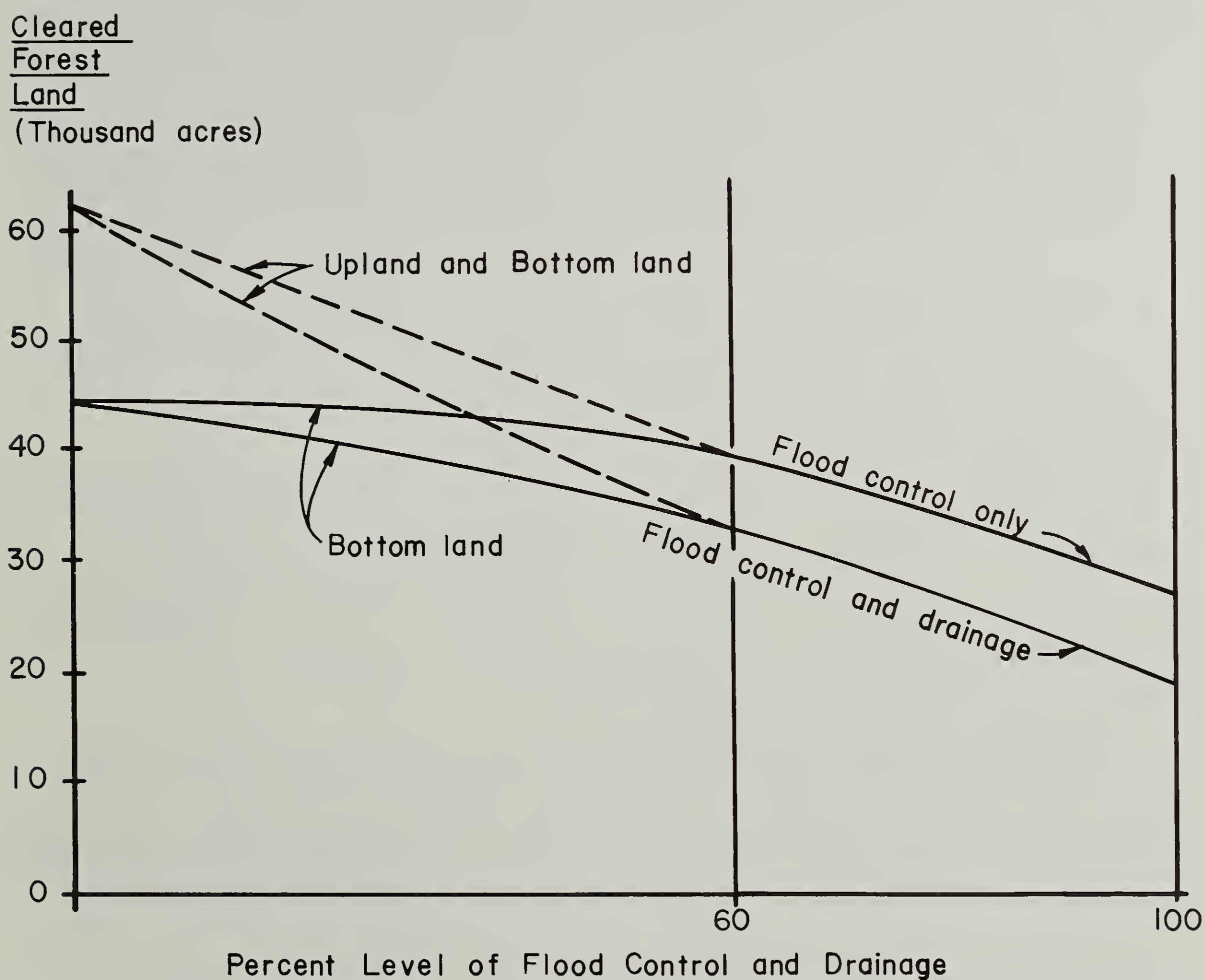


Table 73.--Projected Net Agricultural Income, for Three Assumed Conditions Without Resource Development for Year 2000, Blackwater-Lamine River Basin, Missouri

Item	Net agricultural income: Bottom land	Upland	Total
	- - - - - 1000 dollars - - - - - -		
Base year 1970	6,323	20,761	27,084
Year 2000:			
Constant land use	8,998	29,565	38,563
Minimum cost land use	14,571	37,806	52,377
Maximum profit land use	19,839	72,453	92,292
Increase above base year by year 2000:			
Constant land use	2,675	8,804	11,479
Minimum cost land use	8,248	17,045	25,293
Maximum profit land use	13,516	51,692	65,208

The economic incentive for changing land uses in various areas of the basin is indicated by data in (Table 74). The large gain in net income could be attained by shifting land with a drainage problem into more profitable uses. The least gain in income would accrue from shifting land with both flooding and drainage problems into more profitable uses. These data indicate that sizeable gains in income would accrue by shifting uses of land even if drainage and flood control developments are not undertaken.

Table 74.--Possible Increases in Net Agricultural Income Per Acre Above Constant Land Use for Alternative Conditions, Without Resource Development for the Year 2000, Blackwater-Lamine River Basin, Missouri

Land area	Possible increase in net returns 1/ to crop and pasture above constant land use: Minimum cost	Maximum profit
	- - - - -dollars per acre - - - - -	
Flooding problem only	13.78	28.84
Flooding and drainage problem	7.65	28.48
Drainage problem only	24.15	54.03
Bottom land with no problem	18.81	48.35
Total bottom land	14.90	38.51
Total upland	7.42	40.74
Total basin	9.36	40.96

1/ Net returns to land and management.

One of the main purposes of this analysis is to estimate the net agricultural returns to flood control and drainage. Benefits to flood control and drainage were therefore estimated for each of the three future conditions by computing the differences in net agricultural income that would occur with and without resource development. These differences, including land use shifts to increase agricultural products are presented in (Table 75). Data are shown for bottom land problem areas and upland areas in order to explain the importance of the different assumptions for the three conditions.

Net returns to both flood control and drainage will be the highest if each acre of bottom land is shifted to the most profitable crop as represented by the maximum profit condition (Figures 34 and 35). Benefits for this condition are the increase in net returns from flood control and drainage of land that is assumed already in its most profitable use before development occurs. Benefits therefore reflect the maximum from resource development due to crop yield increases and lower unit costs. Two benefit functions are shown for the maximum profit condition. The highest includes benefits from flooding or drainage of 44,594 acres of land assumed cleared with or without resource development. The other includes only the 178,509 acres of bottom land that would be available for crop production if no additional forest land is cleared.

Net benefits from these analysis can be compared to benefits from stage frequency analysis made for specific combinations of reservoirs in plan formulation.

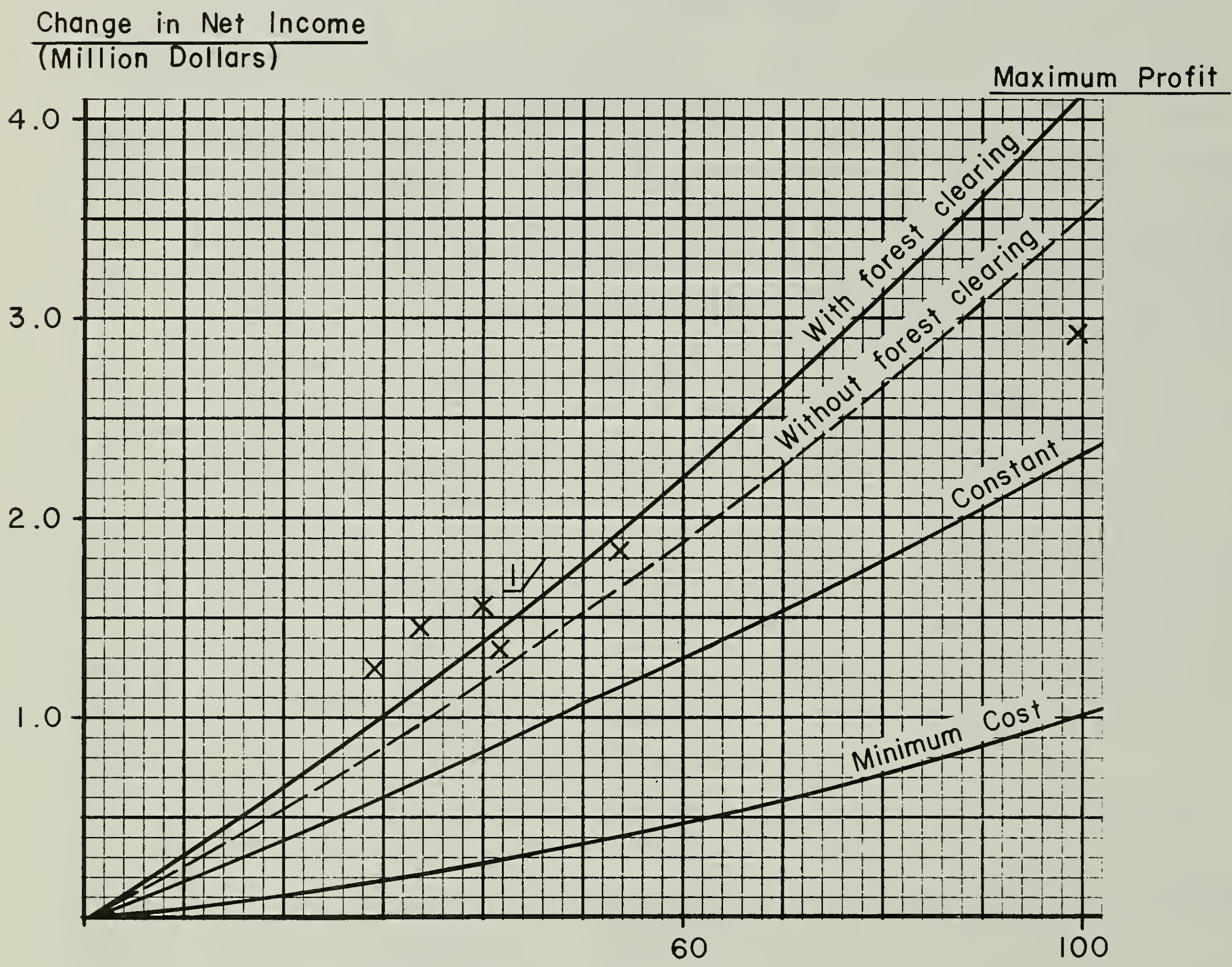
Table 75.--Change in Net Agricultural Income With Resource Development by Areas, for Alternative Conditions for Year 2000, Blackwater-Lamine River Basin, Missouri

	Change in net income with development			
	Level of flood control		Level of drainage	
Condition and land area	60%	100%	60%	100%
	- - - - - - - - 1000 dollars - - - - - - - -			
Constant land use:				
Flooding problem only	655	1,178	0	0
Flooding and drainage problem	635	1,112	302	503
Drainage problem only	0	0	83	138
No problem	0	0	0	0
Total bottom land	1,290	2,290	385	641
Total upland	0	0	0	0
Total all land	1,290	2,290	385	641
Minimum cost land use:				
Flooding problem only	974	1,371	0	434
Flooding and drainage problem	1,286	2,130	239	1,006
Drainage problem only	-63	-836	-65	5
No problem	0	0	0	290
Total bottom land	2,197	2,665	174	1,735
Total upland	-1,734	-1,646	77	-1,096
Total all land	463	1,019	251	639
Maximum profit land use:				
Flooding problem only	977	1,904	0	0
Flooding and drainage problem	1,204	2,217	570	849
Drainage problem only	0	0	350	582
No problem	0	0	0	0
Total bottom land	2,181	4,121	920	1,431
Total upland	0	0	0	0
Total all land	2,181	4,121	920	1,431

The line function representing the relationship between benefits and level of flood control for maximum profit land use closely corresponds to benefits estimated by stage frequency method. In formulating specific plans, combinations of reservoirs were considered by individual watersheds. Anticipated land use with projects was estimated for each flood reach below structures and varied depending on the reduction in flooding that could be accomplished. The shifts of forest land to cropland assumed that flood damages would have to be reduced by at least 50 percent before forest land would be cleared and used as cropland. Increases in net returns due to flood control were based on the reduction in flooding.

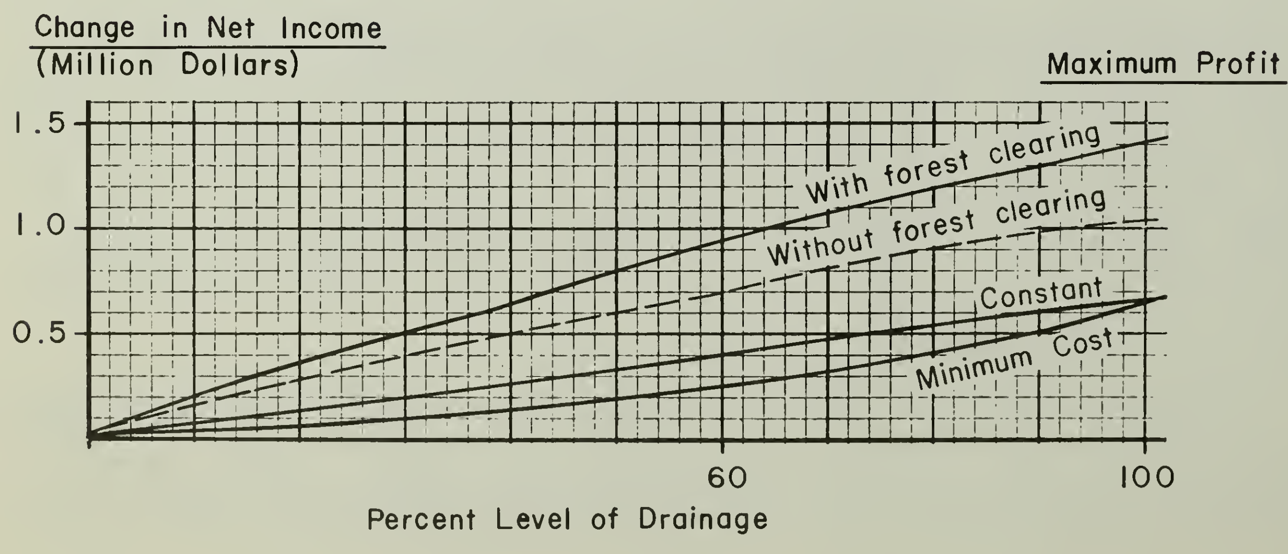
The benefit functions for flood control and drainage for constant land use reflect only the increase in net income resulting from higher crop yields and lower unit costs associated with resource development. These functions are lower than the maximum profit functions because land would remain in the

Figure 34.--Net Agricultural Returns to Flood Control for Three Assumed Conditions for Year 2000, Blackwater-Lamlne River Basin, Missouri



1/ x denotes net benefits estimated for various plan formulations.

Figure 35.--Net Agricultural Returns to Drainage for Three Assumed Conditions for Year 2000, Blackwater-Lamine River Basin, Missouri



present crops with and without development, which is less than the most profitable use.

The basin benefit functions for flood control and drainage are lowest for minimum cost land use conditions because of the restrictive assumption that no more than the projected production requirements for the basin would be produced with development. Because of this assumption, the increase in income from flood protected and drained land would be somewhat offset by a decrease in income in other areas of the basin as resources are combined in a minimum cost manner to produce the given level of farm products. These shifts in income are shown in (Figure 36) for flood control alone and in (Figure 37) for flood control and drainage.

The benefit function for all land is the net function after all positive and negative changes in net agricultural income in the basin have been considered. The benefit function for bottom land includes only the net income changes. The line function for bottom land and the land with a flooding problem are almost identical up to the 60 percent level of flood control (Figure 36). Beyond this level, increases in net income for the area with a flooding problem are partially offset by decreases in income to the land with a drainage problem. This occurs because: (1) Production in the area with a drainage problem is replaced by production in areas with a flooding problem. This is a progressively lower cost area of production as the level of flood protection increases, (2) as flood protection levels increase it is more economical to produce the products on the protected land than to clear forest land with a drainage problem. Thus, production on land with a drainage problem is shifted to flood protected land.

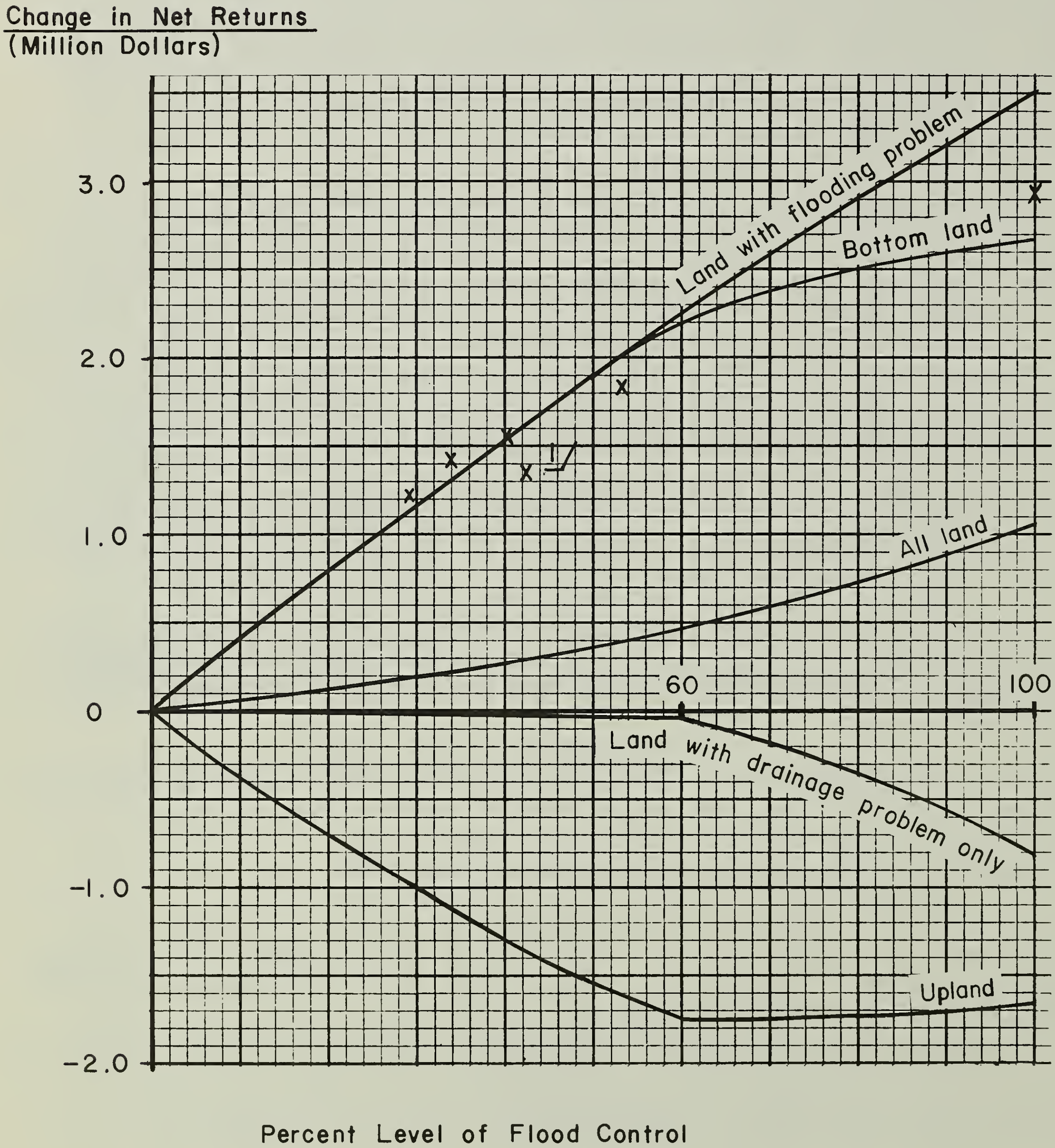
Illustrated is the loss in income to upland areas as production shifts to bottom land for flood control levels below 60 percent. Above 60 percent, the reduction in income shifts to the land with drainage problems and upland income remains about the same.

Benefits estimated for various plan formulations are closely related to the benefit functions for land with flooding problems and bottom land. With drainage added, some offsetting losses in income occur to upland for the entire level of flood control and drainage (Figure 37).

The acreage of cropland and pastureland protected for the 60 and 100 percent level of control for each condition and the corresponding benefits per acre are shown in (Table 76). Benefits for the basin area are the same as the land with a flooding problem for constant and maximum profit conditions because of the assumption that demand for products is not affected by increased production from resource development. For the minimum cost solution, however, benefits to flood control are less when net income shifts associated with other bottom land and upland areas are considered.

If shifts in income in other areas are disregarded and only the changes in income on the flooded land are considered, agriculture benefits are $20.25 per acre for the minimum cost condition at the 60 percent level of control. If adjustments in other areas of the basin are netted, benefits are then $4.15 per acre protected. The maximum benefits possible from yield increases are represented by the maximum profit condition and are $35.00 per acre.

Figure 36.--Change in Net Agricultural Returns With Flood Control, Minimum Cost Condition for Year 2000, Blackwater-Lamine River Basin, Missouri



1/ x denotes net benefits estimated for various plan formulations.

Figure 37.--Change in Net Agricultural Returns With Flood Control and Drainage, Minimum Cost Condition for Year 2000, Blackwater-Lamine River Basin, Missouri

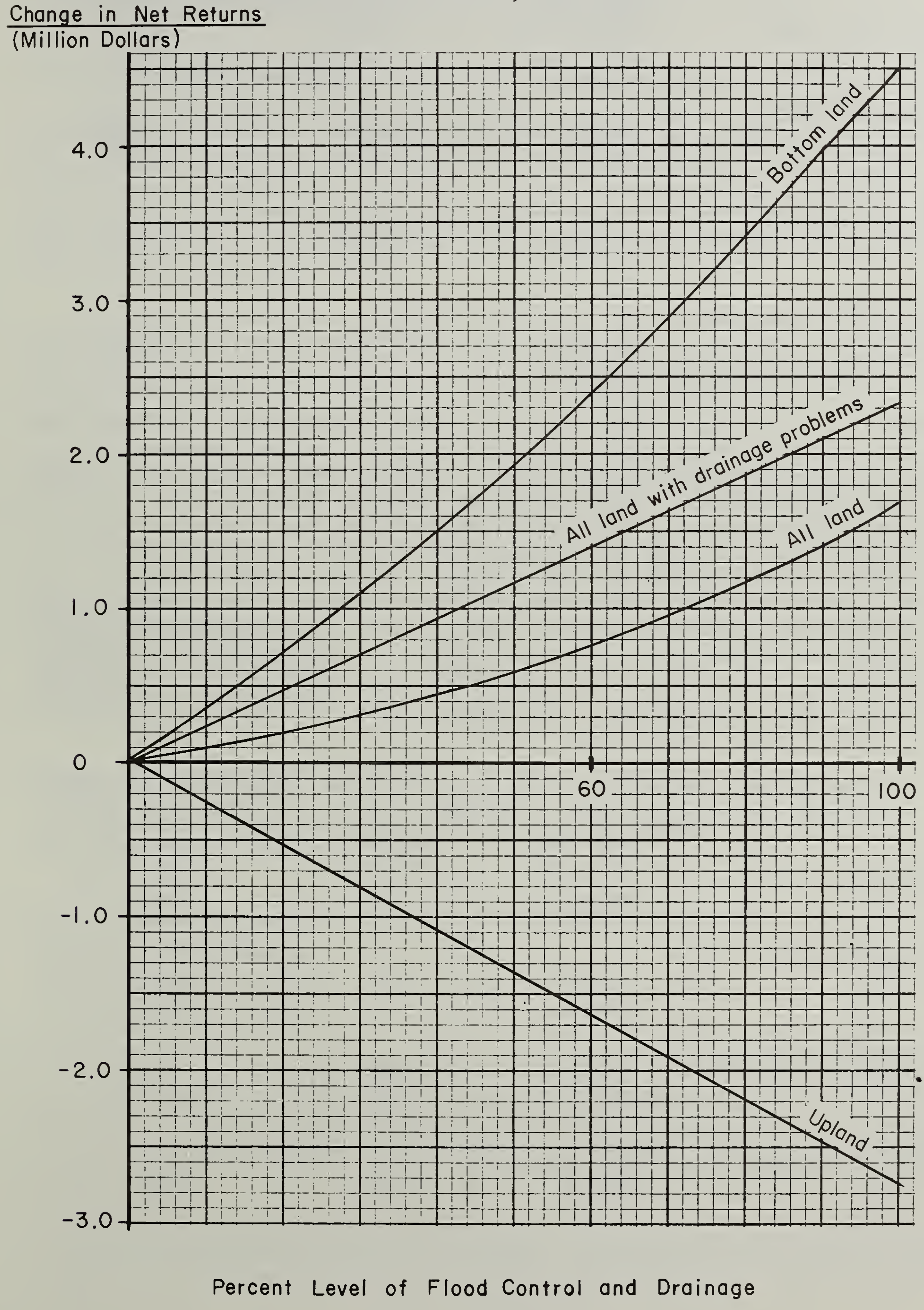


Table 76.--Agricultural Benefits Per Acre to Flood Control for Alternative Conditions for Year 2000, Blackwater-Lamine River Basin, Missouri

Condition and level of flood control	Crop and pastureland protected	Benefits per acre protected	
		Flooded land	Total basin
	- acres -	- - - -dollars per acre - - - -	
Constant land use:			
60% level	99,570	12.96	12.96
100% level	99,570	23.00	23.00
Minimum cost land use:			
60% level	111,592	20.25	4.15
100% level	113,793	30.76	8.95
Maximum profit land use:			
60% level	116,528	18.72	18.72
100% level	116,528	35.36	35.36

Benefits to drainage of crop and pastureland would vary from $3.20 per acre to $14.82 per acre depending on which condition exists (Table 77). An important assumption in the calculation of drainage benefits was that flood control precedes drainage. This assumption was made because three-fourths of the cropland and pastureland with a drainage problem also floods. Because of this assumption, benefits to drainage for the minimum cost condition are lower than if drainage occurred first because changes in land use are credited to flood control. When shifts in net income in other areas of the basin are included, benefits increase from $3.20 to $4.62 per acre at the 60 percent level of control. In this case, drainage permitted other areas of the basin to shift into more profitable crops. The benefits for the minimum cost criteria after 100 percent flood control occurs are a better estimate of drainage benefits for land without a flood problem.

Table 77.--Agricultural Benefits Per Acre to Drainage for Alternative Conditions for the Year 2000, Blackwater-Lamine River Basin, Missouri

Condition and level of drainage	Crop and pastureland drained	Benefits per acre drained	
		Drained land	Total basin
	- acres -	- - - - dollars per acre - - - -	
Constant land use:			
60% level	45,553	8.45	8.45
100% level	75,922	8.45	8.45
Minimum cost land use:			
60% level	54,349	3.20	4.62
100% level	75,922	13.20	8.42
Maximum profit land use:			
60% level	62,089	14.82	14.82
100% level	103,481	13.83	13.83

The annual drainage benefits most likely to be estimated by farmers are in the $8.45 to $14.82 per acre range. The estimated annual cost of drainage is from $6.00 to $8.00 per acre. Thus, drainage would appear to be a feasible investment for many farmers in the basin.

4. Soil Erosion

One of the major factors that affect environmental quality is erosion. The amount of erosion is directly related to the use of upland soils. The gross erosion in the basin is presently far exceeding desirable limits. As tilled crops increase in upland areas so will sheet erosion. The level of sheet erosion is therefore much more dependent upon which set of conditions prevail in the year 2000 than upon flood control or drainage which directly affect only bottom land soils.

If land use remained constant, erosion would be 25 percent less than if the minimum cost conditions occur (Table 78). If the maximum profit conditions prevailed, erosion would increase by two and three-fourths the level for constant land use. This is considered the maximum potential erosion that might occur from agricultural land.

Table 78.--Projected Gross Erosion on Agricultural and Forest Lands With and Without Resource Development for Year 2000, Blackwater-Lamine River Basin, Missouri

Item	Million tons	Tons per acre	Index
Constant land use:			
Without development	18.6	12.2	100
With 100% flood control	18.6	12.2	100
With 100% flood control and drainage	18.6	12.2	100
Minimum cost land use:			
Without development	23.1	15.1	125
With 100% flood control	22.1	14.5	119
With 100% flood control and drainage	22.1	14.5	119
Maximum profit land use:			
Without development	51.1	33.7	276
With 100% flood control	51.1	33.7	276
With 100% flood control and drainage	51.1	33.7	276

Flood control and drainage development may affect erosion very little (Table 78). In only the minimum cost case would erosion levels be reduced and then only by 6 percent. Less erosion would occur in this case because of some shifts in tilled acreage from upland to bottom land areas when flood control occurs.

Several management and land treatment measures could be used to reduce erosion on tilled upland soils and increase water quality. These measures

could be applied to any of the assumed sets of conditions to reduce the level of erosion from that projected.

5. Economic and Environmental Tradeoffs

Agricultural income in the basin can be increased significantly in the future but not without environmental consequences. The highest potential for increasing income is by shifting land to crops yielding the highest profit. Unfortunately, environmental side-effects including wildlife habitat loss and reduced areas for recreation would also be highest.

A summary of the net agricultural income for the three conditions and the measures of other factors associated with these conditions is presented in (Table 79). If shifts to the highest income crops are made, the maximum potential agricultural income to the basin is 92.3 million dollars. This could be increased to 94.5 million if a 60 percent level of flood control were provided and to 95.5 million if 60 percent of the land with a drainage problem were also drained. A comparison of similar income figures for constant and minimum cost land use condition indicates that the major potential for increasing net income lies in changing land uses. The actual level of income and land uses that will prevail in the year 2000 is between the two extremes of constant and maximum profit conditions.

If the national demand for corn, soybeans, sorghum, and wheat remains at a very high level as implied by the maximum profit conditions, significant changes in land use will probably occur whether flood control and drainage are undertaken or not. Net agricultural income will be high, but forested areas will dwindle and forest products income will decrease while erosion may increase by three times the present rate as tilled crops replace pasture, hay and timber.

If the demand for agricultural products is as projected from the minimum cost conditions, land will still shift from pasture and forest into tilled crops but to a less extent than if the demand for products is unlimited at the projected prices as assumed for the maximum profit conditions. Net agricultural income will increase significantly over what it would be if land use remained constant, but erosion will also be higher because of more tilled upland. In this case, flood control and drainage development could lead to a decrease in the amount of forest land that would need to be cleared and a slight reduction in erosion. Although the substitution of production from flood control and drainage for clearing of forests may not occur entirely within the basin, it is a valid generalization at the regional and national level.

Environmental quality is closely associated with land use. The more diverse the land use, the higher the environmental quality. Of particular significance are the tracts of forest land intermingled with open cropland and pastureland along the streams. These forested tracts provide cover for wildlife and add variety to the landscape. They are also potential prime agricultural land.

Most of the 69,700 acres of remaining forested bottom land are subject to flooding, a wetness problem, or both. Flooding occurs on about 47 percent, wetness is a problem on 67 percent, and only 10 percent is not subject to

Table 79.--Summary of Variables for Three Projected Conditions for Year 2000, Blackwater-Lamine River Basin, Missouri

Item	Constant land use	Minimum cost land use	Maximum profit land use
	- - - -million dollars - - - - -		
Net Agricultural Income:			
Without development	38.6	52.4	92.3
60% flood control	39.9	52.8	94.5
60% flood control and drainage	40.2	53.1	95.5
	- - - - - thousand acres - - - - -		
Forested Land:			
Without development	281.9	219.6	219.6
60% flood control	281.9	244.2	219.6
60% flood control and drainage	281.9	250.7	219.6
	- - - - - million tons - - - - -		
Gross Erosion:			
Without development	18.6	23.1	51.1
60% flood control	18.6	22.0	51.1
60% flood control and drainage	18.6	22.1	51.1
	- - - percent of requirements - -		
Agricultural Production:			
Tilled crops			
Without development	75	100	245
60% flood control	77	100	247
60% flood control and drainage	78	100	252
Pasture and hay			
Without development	99	100	0
60% flood control	100	100	0
60% flood control and drainage	101	100	0

either one or both of these problems (Figure 24). It might appear that flooding and wetness problems are the main reasons that these tracts have remained forested. However, there is no evidence to support this as no correlation was found between the severity of flooding and forested land use. The decision to clear a forested area is apparently made on the basis of the individual farm organization rather than on the basis of the flooding hazard. This explains why some tracts with little or no flooding remain forested while other with severe flooding hazards have been recently cleared. This also adds credance to the contention that the most important factor that will govern clearing of bottom land forests, lacking a policy for preserving them, is the levels of demand for agricultural products and the monetary gain.

If the public's major goal is to retain selected forested bottom land areas for environmental purposes, the rights to these forested tracts must be acquired by the public. Otherwise, it is highly probable that many will be cleared and used in their highest economic use--the production of agricultural products.

CHAPTER V

Formulation of Alternative Plans

FORMULATION OF ALTERNATIVE PLANS

Most of the basic data for this study was gathered and evaluations started before Principles and Standards were issued by the U.S. Water Resources Council. Alternatives are displayed for the four accounts, National Economic Development, Regional Development, Environmental Quality and Social Well-Being.

Three alternative plans are presented. Alternative Plans A and B are two different economic plans. Alternative Plan A maximizes net primary benefits. Alternative Plan B results in a favorable cost/benefit ratio but reflects local desires such as the size and location of structures, influx of people for recreation, local flood problems, and water supply needs.

Local desires were determined from a series of public meetings held throughout the basin. It was publicized at these meetings that alternative plans were being developed in order to determine effects of various plans developed with differing objectives. Generally, floodwater retarding structures in Plan A were too large in size. This results in large acreages being removed from production and thus farmers being displeased. Increasing the number of structures and reducing their size was highly desirable. Local desires also includes a levee system in one area to give desired flood protection.

Alternative Plan C emphasizes the control of erosion and the resulting sediment through land treatment and structural measures and the multiple use of reservoirs for recreation, flood prevention, and water supply. Other objectives included the management and enhancement of biological, archeological, historical, wildlife, and other environmental resources.

CRITERIA AND PROCEDURE

Significant criteria and procedures needed to understand the plans are discussed as a prelude to the plan.

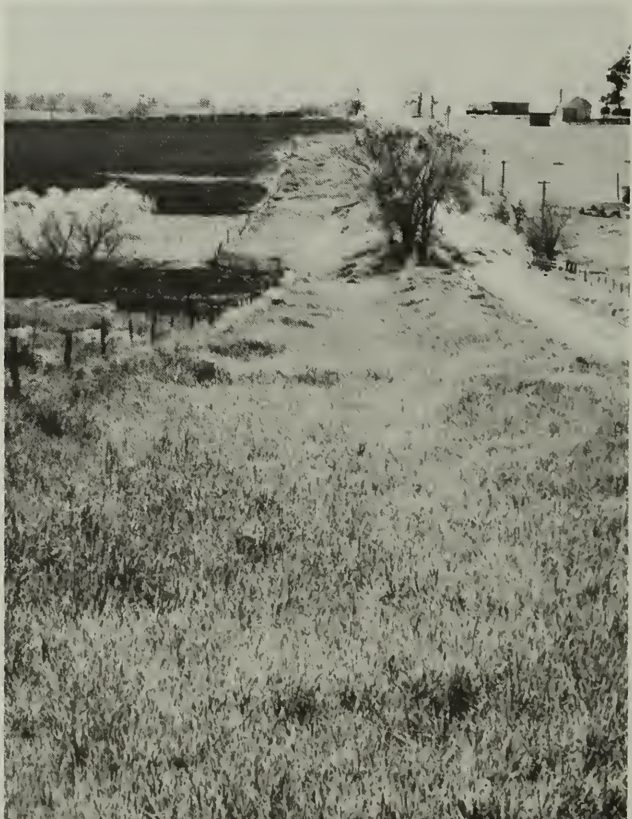
1. Land Treatment

The 1967 Conservation Needs Inventory published in 1970 served as basic information in determining land treatment needs of crop, pasture, and forest lands. The rate of accomplishment under the going programs was projected to year 2000.

Although Alternative Plans A and B are distinct alternatives in other ways, the proposed accelerated land treatment measures are identical. Both plans propose to increase the adequately treated lands to about 65 percent for cropland, 60 percent for pastureland and 35 percent for the forest land of the projected needs for year 2000.

Alternative Plan C accelerates land treatment to about 99 percent for cropland, 85 percent for pasture and 48 percent for forest of the projected needs for year 2000. This plan not only increases the land adequately treated but also concentrates on enhancing the environmental characteristics through erosion control measures, changed land use, and environmental corridors.

Land treatment controls
erosion in cropland,
along roads or
in pastures.



Structures and terraces control gullies and severely eroded areas.

In the three alternative plans, the remaining land to be treated considers the projected land use changes to year 2000. Installation costs for land treatment practices were based on current normal prices. Technical assistance costs were calculated as 25 percent of the installation costs for crop and pasturelands. Technical assistance for forest land treatment varied by measures.

2. Floodwater and Other Structural Measures

An evaluation of present floodwater damages was made by watershed and main stem reaches of the basin. Reach breaks usually occur at locations of major drainage area changes. A limited number of valley cross sections were surveyed. In the 10 mile reach between the confluence of the Blackwater and Lamine Rivers to the Missouri River, floodwater damages were not evaluated since this reach is influenced by the backwater from the Missouri River.

Aerial photographs were used to measure and determine land use on the bottom land. Crop distribution was determined by watershed from samples in each reach. Crop yields, were determined and projected to the year 2000 for each soil productivity group. The gross composite acre values were computed by reaches. Current normal prices issued by the Water Resource Council, February 1974, were used.

A series of storms were flood routed for each alternative. The flood frequency of routed storms were adjusted to correlate with USGS gage data in both the Lamine River and the Blackwater River before using for economic analysis.

Initially 364 floodwater retarding structure sites were located on topographic maps. The criteria used for these selections was based on areas of floodwater damage, drainage areas, and topographic features shown on the map. These sites were then field checked for location of utilities, roads, residents, and general features that might adversely effect installation costs of each structure. The number of streambank erosion control structures was estimated from field investigation and revised channel profiles that give reduced grades and channel velocities.

An economic evaluation was made using 163 potential floodwater retarding structure sites. About 25 percent in each watershed were picked to calculate construction costs using 1972 low bid construction costs. Then using constant dollars, these costs were projected to 1980. Also the 1970 land values were projected to 1980 for land right costs using constant dollars. The engineering cost was estimated at 15 percent of the construction cost. The total installation cost of other structure sites were determined from curves developed from this data. The installation costs were amortized for 100 years at 5 5/8 percent interest rate for annual cost.

The acres of flood plain subject to erosion, sediment and swamping damage were based on field samples at the surveyed cross section. The sample was then expanded to represent the reaches and damages per reach calculated.

Enhancement benefits for more intensive land use and changed land use were restricted to those reaches having at least a 50 percent reduction of damages and for those acres receiving at least 2-year frequency protection.

Reservoirs are opportunities for the development of municipal water supply, irrigation and recreation.

Each structure was allocated a portion of the crop and pasture benefits in a reach according to its drainage area controlled as a percentage of the drainage area controlled by all structures at that reach.

The allocation of annual costs between plan elements was made by separable cost-remaining benefit method. Cost sharing was determined by current applicable watershed policy of individual structures.

Externalities relating to changes in income of businesses economically related to direct and indirect users of the project were measured by the use of an income multiplier for each regional planning area comprising the basin and surrounding area.

3. Recreation

The 1970 State of Missouri Recreation Plan and the population centers in and around the basin were the primary sources of information for analysis of the recreation demands. This information was combined with an evaluation of the limitations and attractions of each area and the availability of desirable reservoir site locations.

The result of the analysis of demand was a Population/Intensity Map of the basin. This combined the population access into areas having equal population pressure called cells. Time zones of one-half to two hours were used from each population center to vary the participation rate.

Seven factors were evaluated on given areas to determine the conditions of the natural setting that will either limit participation or attract participation. The seven factors evaluated were: biological considerations, land forms, soils, water, development pattern, cultural features and special function.

Structure sites considered for recreation were primarily those originally investigated for water supply or flood control. A selection was made from these sites for those with features desirable for recreation development and were used when formulating the alternative plans.

Recreation facilities will provide opportunities needed within 1 1/2 hours of Metropolitan Kansas City.

ALTERNATIVE PLAN A - BLACKWATER-LAMINE RIVER BASIN

1. Land Treatment

The Conservation Needs Inventory indicates that 29 percent of the cropland, 28 percent of the pastureland and 11 percent of the forest land is adequately treated. An ongoing program of land treatment is being applied by Soil and Water Conservation Districts with assistance from the Soil Conservation Service. The treatment of forest lands is being applied through existing USDA, Forest Service and State of Missouri Cooperative Forestry Programs. This ongoing land treatment program is expected to treat an additional 178,000 acres of cropland and 93,800 acres of pastureland by the year 2000. At this rate of application, half of the cropland and pastureland that existed in 1970 will be treated by the year 2000. An additional 12,000 acres of forest land will be treated under the ongoing forestry programs which raises the adequately treated forest lands to 15 percent.

The primary treatment needed on cropland is the acceleration of minimum tillage and mechanical practices such as waterways, terraces, and diversions on 98,800 acres. The primary treatment on pastureland is the improvement and reestablishment of cover on 28,050 acres. Forest land treatment needs center around reforestation, timber stand improvement and grazing reduction.

Land treatment included in Alternative Plans A and B are the same: Expenditures of $3,328,400 are proposed for technical assistance accelerating the planning and treatment of 125,300 acres of cropland, 34,900 acres of pastureland and 30,000 acres of forest land.

Field reconnaissance indicated a need for small land treatment type gully stabilization structures generally in the northern and western part of the basin. The problems are primarily in Soil Association Areas 1, 2, 3 and 4 (Map 10). Alternative Plans A and B recommend installation of 367 gully stabilization structures under the going program and an additional 2018 under an accelerated program.

The total needs for reforestation consist of planting 20,740 acres. Alternative Plans A and B will accelerate reforestation by 1450 acres. This consists of cottonwood plantings for pulpwood production, black walnut plantings for nut and lumber production, and conifers for erosion control. Approximately 14,000 acres of bottom land that is considered high risk for crop production, could be producing pulpwood and sawtimber providing wildlife habitat and enhancing the environment. Since the demand for pulpwood will increase nearly 13 times by the year 2000, an alternative supply of wood fiber is needed. The present growing stock will fill only 19 percent of this demand. Alternative Plans A and B include 800 acres of cottonwood that could be planted by year 2000 under accelerated programs in forest land treatment.

Walnut trees are a high valued timber species and also produce nuts that are a source of income. The walnut stands provide food and cover for wildlife. Hunting and other recreation uses occur in addition to walnut production. Carefully regulated grazing of livestock in the older stands of walnut can be accomplished with little damage to the resources. The ongoing forestry programs provide for 750 acres of black walnut plantings in the

basin. These plantings will be accelerated by an additional 400 acres by year 2000 in both Alternative Plans A and B.

Most reforestation practices in the past have been centered around coniferous species, mainly because of the fast growth rate and erosion control capabilities. The going program proposes planting 2,250 acres in the basin. This forest type is needed along with various hardwood planting. An additional 250 acres is planned for the basin in an accelerated program.

Resource evaluations indicate that 215,590 acres of forest land needs timber stand improvement. The going forestry program will satisfy 6,000 acres of these needs by year 2000. An increase in Timber Stand Improvement activity has been generated by the recent Forestry Incentive Program, but additional TSI is needed to meet the basin needs. Alternative Plans A and B propose 15,150 acres of accelerated TSI above the going program.

Grazing reduction is needed on 14,600 acres of forest land. Going forestry programs are designed to satisfy the need to reduce indiscriminate grazing on 3,000 acres. Proper grazing on any forest land includes careful regulation by fencing. An accelerated program of grazing reduction on 13,400 acres is planned by year 2000.

The demand for wood products in the year 2020 will exceed current supply by 4 million cubic feet. Land treatment alternatives and solutions can improve the resources only through participation of local people and landowners.

Land treatment measures to accelerate the going program are estimated to cost $16,415,000. Included in this cost is $3,328,400 of technical assistance (Table 80).

2. Structural Measures

Alternative Plan A proposes 35 single and multiple purpose floodwater retarding structures. The average drainage area per structure is 23.33 square miles. Fourteen structures are single purpose flood prevention, three are multiple purpose with flood prevention and municipal water storage and eighteen are multiple purpose with flood prevention and recreation.

3. Recreational Development

The 18 multiple purpose structures in Plan A will provide 6,300 surface acres of water for recreation activities. Adjacent to the reservoirs, an additional 12,000 acres of land is proposed for basic recreational facilities. These facilities are expected to supply 2,305,800 recreational visits annually and result in $3,458,550 in recreation benefits (Table 81).

Table 80.--Land Treatment for Year 2000, Alternative Plans A and B, Blackwater-Lamine River Basin, Missouri

Conservation treatment	Going program: Area treated	Going program: Cost	Accelerated treatment: Area treated	Accelerated treatment: Cost
	-acres-	-dollars-	-acres-	-dollars-
CROPLAND				
Annual cover	3,200	17,000	2,000	10,600
Meadow in rotation	7,200	47,900	5,000	33,300
Contour farming	3,900	5,200	2,700	3,600
Terracing, diversions, no till	139,900	5,714,800	98,800	4,003,500
Permanent cover	6,300	165,900	4,700	123,800
Drainage	17,500	116,400	12,100	80,500
Total cropland	178,000		125,300	
Installation cost		6,067,200		4,255,300
Technical assistance		1,516,800		1,063,800
Total cropland cost		7,584,000		5,319,100
PASTURE				
Not feasible to treat	100		100	
Protection from overgrazing	4,800	6,400	2,500	3,300
Improvement of cover	55,900	743,500	24,685	328,400
Brush control	2,200	38,000	1,000	17,300
Reestablishment of cover	18,400	489,400	4,365	116,100
Brush control & reestablishment	12,400	379,400	2,250	68,800
Total pasture	93,800		34,900	
Installation cost		1,656,600		533,900
Technical assistance		414,100		133,500
Total pasture cost		2,070,700		667,400
FOREST				
Reforestation	3,000	174,000	1,450	83,800
Timber stand improvement	6,000	270,000	15,150	681,600
Grazing reduction	3,000	105,000	13,400	469,000
Total forest	12,000		30,000	
Installation cost		549,000		1,234,400
Technical assistance		241,100		365,400
Total forest cost		790,000		1,599,800
	-number-		-number-	
GULLY STABILIZATION STRUCTURES	367		2,018	
Installation cost		1,284,700		7,063,000
Technical assistance		321,100		1,765,700
Total gully stabilization cost		1,605,800		8,828,700
TOTAL LAND TREATMENT				
Installation cost		9,557,500		13,086,600
Technical assistance		2,493,100		3,328,400
Total land treatment cost		12,050,600		16,415,000

Table 81.--Water Based Recreation Potential Satisfied by Alternative Plan A, Blackwater-Lamine River Basin, Missouri

	Unit	Total
Structures	Number	18
Surface area	Acres	6,300
Basic facilities	Acres	12,000
Activities:		
Fishing	Visits	315,000
Boating	Visits	599,200
Camping	Visits	447,200
Picnicking	Visits	704,200
Sight seeing	Visits	180,200
Swimming	Visits	60,000
Total activities	Visits	2,305,800
Annual benefits	Dollars	3,458,550

Display #1.--National Economic Development Account, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Components	Measures of effects 1/ (Average annual dollars)
A. Value to users of increased outputs of goods and services	
1. Flood prevention	2,961,910
2. Water supply municipal	129,150
3. Recreation	3,458,550
4. Utilization of employment and unemployment labor resources	241,780
Total Beneficial Effects	6,791,390
Net Beneficial Effects	2,370,640

ADVERSE EFFECTS

Components	Measures of effects 2/ (Average annual dollars)
A. Value of resources required for the plan	
1. 14 single purpose flood prevention structures	
Project Installation	401,030
OM&R	18,650
2. 3 multiple-purpose structures (FP & MI)	
Project Installation	123,500
OM&R	5,650
3. 18 multiple-purpose structures (FP & Rec)	
Project Installation	2,300,800
OM&R	1,205,060
4. Project Administration	366,060
5. Land Treatment	
Total Adverse Effects	4,420,750

1/ Installation cost of accelerated land treatment, including technical assistance is estimated to be $16,415,000. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #2.--Environmental Quality Account, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 8,878 acres of permanent water.
	2. Permanent inundation of 4,518 acres of cropland, 1,437 acres of pastureland, and 2,923 acres of forest land.
	3. Temporary inundation of 5,687 acres of cropland, 2,052 acres of pastureland, and 3,885 acres of forest land.
	4. Disruption in tranquility of rural environment by providing 2,305,800 recreation visitor days.
	5. Changed land use of 5,682 acres of pastureland and 5,640 acres of forest land to cropland.
	6. Associated land areas for recreation facilities will occupy 12,000 acres composed of 6,410 acres cropland, 2,020 acres of pastureland and 3,570 acres forest land.
	7. 153,165 acres of managed forest land retains natural beauty.
B. Quality considerations of water, land and air resources.	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Provides increased quality of water on 215,565 acres.
	4. Reduction in erosion on 97,307 acres of grazed forest land.
	5. Reduction in noise and air pollution by establishment of 10,350 reforested acres.
	6. Reduction of 6.42 tons/acre of annual erosion.
C. Biological resources selected ecosystems.	1. Permanently inundate 28 miles of perennial stream and 20 miles of intermittent streams presently supporting warm water stream fisheries with varying populations.

Display #2.--Environmental Quality Account, Alternative Plan A, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
C. Biological resources selected ecosystems (continued).	2. Temporarily inundate at a 2-year frequency 5.2 miles of perennial and 5.2 miles of intermittent streams. At a 50-year frequency, inundation will occur on 23.5 miles of perennial streams and 20.5 miles of intermittent streams.
	3. Permanently inundate 8,858 acres of terrestrial and riparian habitat associated with the reservoir areas of the structure.
	4. Temporarily inundate at a 2-year frequency 3,383 acres of terrestrial and reparian habitat. At a 50-year frequency inundation will effect 12,626 acres of habitat.
	5. Create 8,878 acres of lake water fish habitat in the 1,368 acres of sediment pools, 6,300 acres of recreation pools, and 1,210 acres of municipal and industrial water pools.
	6. Provide 8,858 acres of resting areas for waterfowl, of which 1,940 acres will be less than 2 feet deep.
	7. 147,965 acres of forest land will be dedicated to wildlife habitat enhancement.
	8. Establishment of 2,885 acres of black walnut increasing food supply for squirrels and other wildlife.
	9. Forest ecosystems are provided on 10,350 reforested acres.
	10. Temporarily disrupts wildlife habitat during harvest years.
D. Irreversible of irretrievable commitments.	1. Changed land use of 4,518 acres of cropland, 1,437 acres pasture-land and 2,923 acres of forest land to permanent water.

Display #3.--Regional Development Account, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of increased output of goods and services of users residing in the region		
1. Flood prevention	2,961,910	
2. Water supply municipal	129,150	
3. Recreation	779,040	2,659,510
4. Utilization of employment and unemployed labor resources	241,780	

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of resources required for a plan		
1. 14 single-purpose flood prevention structures		
Project Installation	97,930	303,100
OM&R	18,650	
2. 3 multiple-purpose structures (FP & MI)		
Project Installation	100,140	23,360
OM&R	5,650	
3. 18 multiple-purpose structures (FP & Rec)		
Project Installation	972,230	1,328,570
OM&R	1,205,060	
4. Project Administration	2,750	363,310

Display #3.--Regional Development Account, Alternative Plan A, Blackwater-Lamine River Basin, Missouri (continued)

Income:

BENEFICIAL EFFECTS			ADVERSE EFFECTS		
Components	Measures of effects 1/		Components	Measures of effects 2/	
	Basin	Rest of nation		Basin	Rest of nation
	(Average annual dollars)			(Average annual dollars)	
B. The value of output resulting from external economics			B. Losses of output resulting from external diseconomics to users residing in the region		
1. Indirect activities associated with increased net returns from flood prevention and recreation	3,700,890	-3,700,890	1. Indirect activities from reservoir take areas	1,243,900	-1,243,900
Total Beneficial Effects	7,832,770	-1,041,380	Total Adverse Effects	3,646,310	774,440
Net Beneficial Effects	4,186,460	-1,815,820			

1/ Installation cost of accelerated land treatment, including technical assistance, is estimated to be $16,415,000. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #3.--Regional Development Account, Alternative Plan A, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS

Employment:

Components

A. Increase in the number and types of jobs
   1. Employment for project construction
      142.9 semi-skilled jobs for 10 years
   2. Employment for project OM&R
      3.2 permanent semi-skilled jobs
   3. Employment in recreation sector OM&R
      85.0 permanent seasonal semi-skilled jobs
   4. Employment in land treatment construction
      64.1 semi-skilled jobs for 10 years
      1 skilled forester
      10 semi-skilled forestry jobs in 10 years
   5. Employment in land treatment OM&R
      16.5 permanent semi-skilled jobs
   6. Employment in externalities
      112.4 permanent semi-skilled jobs

Total Beneficial Effects
- 217.0 semi-skilled jobs for 10 years
- 132.1 permanent semi-skilled jobs
- 85.0 permanent seasonal semi-skilled jobs
- 1.0 skilled forester

Net Beneficial Effects
- 217.0 semi-skilled jobs for 10 years
- 53.4 permanent semi-skilled jobs
- 85.0 permanent seasonal semi-skilled jobs
- 1.0 skilled forester

ADVERSE EFFECTS

Components

A. Decrease in numbers and types of jobs
   1. Associated with reservoir take area
      78.7 permanent semi-skilled jobs

Display #4.--Social Well-Being Account, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Create 53.4 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $7,832,770 by income class as follows:
	3. Regional costs of $3,646,310 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoir areas will provide an increased potential of 315,000 fisherman days per year of lake fishing.
	2. Inundation of stream fishing will result in a loss of 3200 fisherman days annually of stream fishing.
	3. Inundation of terrestrial and riparian habitat at reservoir areas will result in a loss of 1485 hunter days annually.
	4. Providing public use areas in association with recreational developments will provide an additional 2574 hunter days annually.
	5. Create 2,305,800 recreation visitor days.

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	7
3000 - 10,000	54	43
More than 10,000	32	50

ALTERNATIVE PLAN B - BLACKWATER-LAMINE RIVER BASIN

1. Land Treatment

The land treatment measures proposed for Alternative Plan B are identical to those proposed for Alternative Plan A, Chapter V-B.

2. Structural Measures

Alternative Plan B proposes 102 single and multiple purpose floodwater retarding structures in the basin. Eighty-nine structures are single purpose flood prevention, three are multiple purpose with flood prevention and municipal water storage and 10 are multiple purpose flood prevention and recreation.

3. Channel Work

There is 13.1 miles of levee planned to protect 3,243 acres of bottom land from a 25-year frequency flood. Within this protected area, a drainage system would be installed with a pumping plant that would remove the excess water.

4. Recreational Development

The 10 multiple purpose structures will provide 2,430 acres of water for recreation activities. Adjacent to the reservoirs, there are 4,800 acres of land proposed for basic recreation facilities. These facilities are expected to supply 892,910 recreation visits with benefits of $1,339,260 annually (Table 82).

Table 82.--Water Based Recreational Potential Satisfied by Alternative Plan B, Blackwater-Lamine River Basin, Missouri

	Unit	Total
Structures	Number	10
Surface area	Acres	2,430
Basic facilities	Acres	4,860
Activities:		
Fishing	Visits	121,500
Boating	Visits	196,400
Camping	Visits	200,200
Picnicking	Visits	309,810
Sight seeing	Visits	65,000
Swimming	Visits	0
Total activities	Visits	892,910
Annual benefits	Dollars	1,339,260

Display #5.--National Economic Development Account, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Components	Measures of effects 1/ (Average annual dollars)
A. Value to users of increased outputs of goods and services	
1. Flood prevention	3,771,700
2. Water supply municipal	129,150
3. Recreation	1,339,260
4. Utilization of employment and unemployment labor resources	222,380
5. Drainage	74,070
Total Beneficial Effects	5,536,560
Net Beneficial Effects	1,546,980

ADVERSE EFFECTS

Components	Measures of effects 2/ (Average annual dollars)
A. Value of resources required for plan	
1. 89 single-purpose flood prevention structures	
Project Installation	1,513,970
OM&R	71,200
2. 3 multiple-purpose structures (FP & MI)	
Project Installation	123,500
OM&R	5,650
3. 10 multiple-purpose structures (FP & Rec)	
Project Installation	1,037,550
OM&R	478,980
4. Levee and drainage	
Project Installation	220,900
OM&R	143,620
5. Project Administration	
Structural measures	394,210
6. Land treatment	
Total Adverse Effects	3,989,580

1/ Installation cost of accelerated land treatment, including technical assistance, is estimated to be $16,415,000. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #6.--Environmental Quality Account, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 8,474 acres of permanent water.
	2. Permanent inundation of 4,099 acres of cropland, 1,470 acres of pastureland, and 2,905 acres of forest land.
	3. Temporary inundation of 11,244 acres of cropland, 3,939 acres of pastureland and 6,730 acres of forest land.
	4. Disruption in tranquility of rural environment by providing 892,910 recreation visitor days.
	5. Changed land use on 6,655 acres of pastureland and 8,123 acres forest land to cropland.
	6. Levee 13.1 miles long protecting 3,243 acres of bottom land.
	7. Associated land areas for recreation facilities will occupy 2,478 acres cropland, 1,142 acres of pasture and 1,240 acres forest land.
	8. 183,798 acres of managed forest land retains natural beauty.
B. Quality considerations of water, land and air resources	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Provides measured quality of water on 258,678 acres.
	4. Reduction in erosion on 116,767 acres of grazed forest land.
	5. Reduction in noise and air pollution by establishment of 12,442 reforested acres.
	6. Reduction of 7.14 tons/acre of annual erosion.
C. Biological resources selected ecosystems	1. Permanently inundate 5.1 miles of perennial streams and 30.5 miles of intermittent streams presently supporting warm water stream fisheries with varying populations.

Display #6.--Environmental Quality Account, Alternative Plan B, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
C. Biological resources selected ecosystems (continued)	2. Temporarily inundate at a 2-year frequency 1 mile of perennial and 7.35 miles of intermittent streams. At a 50-year frequency inundation will occur on 4 miles of perennial streams and 30.5 miles of intermittent streams.
	3. Permanently inundate 8,460 acres of terrestrial and riparian habitat associated with the reservoir areas of the structures.
	4. Temporarily inundate at a 2-year frequency 5,550 acres terrestrial and riparian habitat. At a 50-year frequency inundation will effect 22,000 acres of habitat.
	5. Create 8,474 acres of lake water fish habitat in the 4,834 acres of sediment pools, 2,430 acres of recreation pools and 1,210 acres of municipal and industrial water pools.
	6. Provide 8,466 acres of resting areas for waterfowl, of which 1,700 acres will be less than 2 feet deep.
	7. 177,558 acres of forest land will be dedicated to wildlife habitat.
	8. Establishment of 4,442 acres of black walnut increases food supply for squirrels and other wildlife.
	9. Forest ecosystems are provided on 12,442 reforested acres.
	10. Temporarily disrupts wildlife habitat during harvest years.
D. Irreversible or irretrievable commitments	1. Changed land use of 4,099 acres of cropland, 1,470 acres pasture-land and 2,905 acres of forest land to permanent water.

Display #7.--Regional Development Account, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of increased output of goods and services to users residing in the region		
1. Flood prevention	3,771,700	
2. Water supply municipal	129,150	
3. Recreation	355,520	983,740
4. Utilization of employment and unemployment labor resources	222,380	
5. Drainage	74,070	

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of resources required for a plan		
1. 89 single-purpose flood prevention structures		
Project Installation	357,710	1,156,260
OM&R	71,200	
2. 3 multiple-purpose structures (FP & MI)		
Project Installation	99,050	24,450
OM&R	5,650	
3. 10 multiple-purpose structures (FP & Rec)		
Project Installation	455,005	582,545
OM&R	478,980	
4. Project Administration		
Structural measures	5,800	388,410
5. Levee and drainage		
Project Installation	182,860	38,040
OM&R	143,620	

Display #7.--Regional Development Account, Alternative Plan B, Blackwater-Lamine River Basin, Missouri (continued)

Income:

BENEFICIAL EFFECTS

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
B. The value of output resulting from external economies		
1. Indirect activities associated with increased net returns from flood prevention and recreation	3,433,030	-3,433,030
Total Beneficial Effects	7,985,850	-2,449,290
Net Beneficial Effects	5,139,555	-3,592,575

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
B. Losses of output resulting from external diseconomies to users residing in the region		
1. Indirect activities from reservoir take areas	1,046,420	-1,046,420
Total Adverse Effects	2,846,295	-1,143,285

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $16,415,000. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #7.--Regional Development Account, Alternative Plan B, Blackwater-Lamine River Basin, Missouri
(continued)

BENEFICIAL EFFECTS	ADVERSE EFFECTS
Employment:	
Components	Components
A. Increase in the number and types of jobs	A. Decrease in numbers and types of jobs
1. Employment for project construction	1. Associated with reservoir take areas
152.8 semi-skilled jobs for 10 years	66.3 permanent semi-skilled jobs
2. Employment for project OM&R	
10.1 permanent semi-skilled jobs	
3. Employment in recreation sector OM&R	
33.4 permanent seasonal semi-skilled jobs	
4. Employment in land treatment construction	
64.1 semi-skilled jobs for 10 years	
10.0 semi-skilled forestry jobs for 10 years	
1.0 skilled forester	
5. Employment in land treatment OM&R	
16.5 permanent semi-skilled jobs	
6. Employment in externalities	
47.2 permanent semi-skilled jobs	
Total Beneficial Effects	
226.9 semi-skilled jobs for 10 years	
73.8 permanent semi-skilled jobs	
33.4 permanent seasonal semi-skilled jobs	
1.0 skilled forester	
Net Beneficial Effects	
226.9 semi-skilled jobs for 10 years	
7.5 permanent semi-skilled jobs	
33.4 permanent seasonal semi-skilled jobs	
1.0 skilled forester	

Display #8.--Social Well-Being Account, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Create 7.5 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $7,985,850 by income class as follows:
	3. Regional costs of $2,846,295 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoir areas will provide an increased potential of 121,500 fisherman days per year of lake fishing.
	2. Inundation of stream fishing will result in a loss of 675 fisherman days annually of stream fishing.
	3. Inundation of terrestrial and riparian habitat at reservoir areas will result in a loss of 1364 hunter days annually.
	4. Providing public use areas in association with recreational developments will provide an additional 928 hunter days annually.
	5. Create 892,910 recreational visitor days.

Income distribution (item A.2):

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	4
3000 - 10,000	54	42
More than 10,000	32	54

ALTERNATIVE PLAN C - BLACKWATER-LAMINE RIVER BASIN

1. Land Treatment

Alternative Plan C provides for a high level of land treatment. Accelerated treatment on 248,400 acres of cropland will bring the adequately treated cropland to 673,500 acres or 80 percent of the 1970 acres of cropland. The treatment practices on Class II and III lands are in accord with the Conservation Needs Inventory. Treatment on Class IV, VI and VII cropland is orientated toward reducing erosion and sediment production and enhancing the environmental quality.

Treatment will be accelerated by 134,600 acres of pastureland increasing the adequately treated pastureland to 346,200 acres or about 82 percent of the 1970 pasture acres. In Classes IV, VI and VII the plan is orientated toward planting species of grasses and afforestation to reduce erosion, enhance wildlife and improve the environmental quality.

Accelerated treatment is proposed on 60,000 acres of existing forest lands. Reforestation will be accelerated by planting 2,000 acres of cottonwood plantings, 600 acres of black walnut and 300 acres of conifers. Timber stand improvement will be accelerated on 30,290 acres and grazing will be reduced on 26,810 acres.

Projected land use changes without project development predicts a considerable loss of forest lands in the basin. This loss is going into nonfarm and agricultural purposes. Environmentally, a reduction of timber is considered undesirable. Alternative Plan C proposes a land treatment program to preserve existing woodlands and adjust land usage to achieve environmental values.

In order to stabilize the land resource, Class VII lands should remain in native or natural vegetation--forests or range. Cultivation of Class IV lands require intensively managed conservation practices and many times are better suited to a permanent vegetation. Much of the Class IV, VI, and VII lands have potential for commercial forest land.

The forest conversion could be done on lands that have commercial timber possibilities while lands that have no commercial timber possibilities would be converted to native grasses (Table 83). The table shows present land use and the potential land uses if the conversion was made.

Alternative Plan C proposes 100,800 acres of Class IV, VI and VII crops and pasture be converted to forest (Table 84). Potentially 145,400 acres have a woodland site potential greater than 60 feet leaving 48,900 acres of pasturelands that have a low woodland potential. About 41,800 acres are proposed to be converted to native warm season grass. Also included is 13,100 acres of Class IV crop and pasturelands to be converted to tame grasses. Achievement of these goals would stabilize soil resources and create a landscape of diverse uses that would achieve environmental purposes at minimal economic losses.

Planting trees and warm season grasses will use land within its capability, reduce erosion and provide additional income.

Table 83.--Land Use Changes Potential by Land Classes, Blackwater-Lamine River Basin, Missouri

Land Use	PRESENT				
Land Class	I, II, III	IV	VI	VII	Total
	acres				
TOTAL BASIN					
Cropland	750,300	76,400	14,600	5,500	846,800
Pasture	289,700	85,200	31,200	17,200	423,300
Forest	130,400	49,200	39,100	79,000	297,700
Other	36,800	2,700	2,100	2,700	44,300
Total	1,207,200	213,500	87,000	104,400	1,612,100
Land Use	POTENTIAL				
TOTAL BASIN					
Cropland	750,300	0	0	0	750,300
Pasture	289,700	56,000	19,400	9,300	374,300
Forest	130,400	154,800	65,500	92,400	443,100
Other	36,800	2,700	2,100	2,700	44,300
Total	1,207,200	213,500	87,000	104,400	1,612,100

Table 84.--Land Use and Land Use Changes from Without Project, Plan C, Year 2000, Blackwater-Lamine River Basin, Missouri

Land Class	I, II, III	IV	VI & VII	Total
	acres			
LAND USE				
Cropland	766,200	26,700	400	793,300
Change	0	-57,300	-3,400	-60,700
Pasture	289,000	45,100	34,800	368,900
Change	0	-13,900	-26,200	-40,100
Forest	600,000	118,200	142,600	320,800
Change	0	+71,200	+29,600	+100,800
Other	36,200	2,700	4,800	43,700
TOTAL INVENTORY	151,400	192,700	182,600	1,526,700
NON-INVENTORY (Year 2000)				+175,600
TOTAL				1,702,300

About 2,385 gully stabilization structures are proposed in this Alternative Plan. The major erosion problem is in the Blackwater Subbasin. Over 90 percent of the proposed structures (2,177) are planned for this area. There are 208 gully stabilization structures proposed for the Lamine Subbasin.

One of the major sources of sediment in the basin is from roadside erosion primarily along gravel and dirt roads. Roadside erosion control measures are proposed on 2,712 miles of roads. The proposed erosion control would involve increasing the rights-of-way from 66 feet to 80 feet, shaping, installing drop structures where needed, and establishing grass cover on the road ditches.

The total cost of installation of land treatment measures, including gully stabilization and roadside erosion control, is estimated at $37,899,900. Technical assistance costs to install these measures is $11,536,100 resulting in a total cost of $49,436,000 (Table 85).

2. Structural Measures

Alternative Plan C proposes 22 multiple purpose floodwater retarding structures. Three with flood prevention and municipal water storage and nineteen with flood prevention and recreation. The average drainage area per structure is 28.52 square miles. There are 63 grade stabilization structures planned with an average drainage area of 1.76 square miles. Each of these structures would protect an average of 440 acres from severe erosion and soil loss. Also proposed are nine streambank erosion control, rock structures to protect and control streambank erosion on 147,000 feet of channel banks. These structures involve placement of low rock fills across the channel and restoration of associated stream side vegetation reducing velocities, bank sloughing, and bottom degradation. Alternating pool areas and some riffle sections will be created which will produce several environmental benefits including fish and wildlife habitat.

3. Recreational Development

There are 19 multiple purpose structures proposed with storage for recreation and flood prevention. This will provide 6,500 acres of water for recreation facilities. These facilities are expected to supply 2,410,000 recreation visits with an annual value of $3,615,450 (Table 86).

4. Environmental Corridor Development

Recommendations for easements or acquisition to be considered by state, county or municipal governments include the highest environmental value segments of the corridors.

Plan C includes the upper portion of Clear Creek, a tributary to the Blackwater River in Johnson County. The corridor includes 17 miles of stream and 13,500 acres of corridor area. This segment has a rating of 3.5, the highest in the basin. The corridor includes the valley through Knob Noster State Park and also encompasses the proposed multi-purpose flood prevention-recreation structure on Clear Creek in Plan C.

Ten recreation visits per net corridor acre results in 91,000 recreation visits at a minimum value of $0.75 per recreation unit amounting to an annual benefit of $68,250. An easement cost of $160 per acre amortized for a total adverse effect of $82,250, which does not include any cost for recreation facilities.

Other corridors include the lower portion of Heath Creek from the Pettis-Saline County line to its mouth and a segment of the Lower Lamine River from the junction of Skull Creek tributary to the junction of the Lamine River with the Blackwater River.

Table 85.--Land Treatment for Year 2000, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

Conservation treatment	Going program: Area treated	Going program: Cost	Accelerated treatment: Area treated	Accelerated treatment: Cost
	-acres-	-dollars-	-acres-	-dollars-
CROPLAND				
Annual cover	3,200	17,000	3,000	16,000
Meadow in rotation	7,200	47,900	7,400	49,300
Contour farming	3,900	5,200	4,000	5,300
Terracing, diversions and no till	139,900	5,714,800	148,100	5,991,900
Permanent cover	6,300	165,900	7,200	189,900
Drainage	17,500	116,400	18,000	119,700
Establishment of tame grasses			9,400	250,000
Establishment of warm season grasses			14,600	511,000
Afforestation			36,700	2,128,600
Total cropland	178,000		248,400	
Installation cost		6,067,200		9,261,700
Technical assistance		1,516,800		3,251,200
Total cropland cost		7,584,000		12,512,900
PASTURE				
Not feasible to treat	100		100	
Protection from overgrazing	4,800	6,400	2,800	3,700
Improvement of cover	55,900	743,500	27,700	368,400
Brush control	2,200	38,000	1,200	20,700
Reestablishment of cover	18,400	489,400	4,900	130,300
Brush control and reestablishment	12,400	379,300	2,500	76,500
Establishment of tame grasses			3,700	98,400
Establishment of warm season grasses			27,200	952,000
Afforestation			64,100	3,717,800
Total pasture	93,800		134,600	
Installation cost		1,656,600		5,367,800
Technical assistance		414,100		2,976,500
Total pasture cost		2,070,700		8,344,300
FOREST				
Reforestation	3,000	174,000	2,900	167,600
Timber stand improvement	6,000	270,000	30,290	1,363,200
Grazing reduction	3,000	105,000	26,810	938,600
Total forest	12,000		60,000	
Installation cost		549,000		2,469,400
Technical assistance		241,100		730,800
Total forest cost		790,100		3,200,200
	-number		-number-	
GULLY STABILIZATION STRUCTURES	367		2,385	
Installation cost		1,284,700		8,347,500
Technical assistance		321,100		2,086,900
Total gully stabilization cost		1,605,800		10,434,400
	-miles-		-miles-	
ROADSIDE EROSION			2,712	
Installation cost				12,453,500
Technical assistance				2,490,700
Total roadside erosion control cost				14,944,200
TOTAL LAND TREATMENT				
Installation cost		9,557,500		37,899,900
Technical assistance		2,493,100		11,536,100
Total land treatment cost		12,050,600		49,436,000

Table 86.--Water Based Recreation Potential Satisfied by Alternative Plan C, Blackwater-Lamine River Basin, Missouri

	Unit	Total
Structures	Number	19
Surface area lakes	Acres	6,500
Basic facilities	Acres	13,000
Activities:		
Fishing	Visits	325,000
Boating	Visits	629,200
Camping	Visits	457,600
Picnicking	Visits	725,900
Sight seeing	Visits	182,700
Swimming	Visits	90,000
Total activities	Visits	2,410,400
Annual benefits	Dollars	3,615,450

These corridors have ratings of 3.2 and includes 23 miles of stream and 15,900 acres of corridor area. The beneficial effects from 159,000 recreation visits would amount to $119,300 annually. The average annual easement cost of $160 per acre amortized for a total cost of $143,930 annually.

The land use in the flood plain is expected to remain in agricultural production and benefit from the proposed floodwater prevention structures.

Display #9.--National Economic Development Account, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS: Components	Measures of effects 1/ (Average annual dollars)	ADVERSE EFFECTS: Components	Measures of effects 2/ (Average annual dollars)
A. Value to users of increased outputs of goods and services		A. Value of resources required for plan	
1. Flood prevention	1,580,520	1. 3 multiple-purpose structures (FP & MI)	
		Project Installation	123,500
		OM&R	5,650
2. Water supply municipal	129,150	2. 19 multiple-purpose structures (FP & Rec)	
		Project Installation	2,453,020
		OM&R	1,263,640
3. Recreation	3,615,450	3. Erosion Control	
		63 gully stabilization structures	
		Project Installation	278,460
		OM&R	13,970
		9 streambank structures	
		Project Installation	129,690
		OM&R	7,920
4. Utilization of employment and unemployment labor resources	258,900	4. Environmental Corridors Project Installation	226,180
5. Erosion control		5. Project Administration	
Gully stabilization	272,350	Structural measures	398,690
Streambank	13,250		
6. Environmental Corridors	187,550		
Total Beneficial Effects	6,057,170	Total Adverse Effects	4,900,720
Net Beneficial Effects	1,156,450		

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $49,436,000. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #10.--Environmental Quality Account, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 7,710 acres of permanent water.
	2. Permanent inundation of 4,042 acres of cropland, 1,251 acres of pastureland and 2,417 acres of forest land.
	3. Temporary inundation of 3,948 acres of cropland, 1,081 acres of pastureland, and 2,034 acres of forest land.
	4. Disruption in tranquility of rural environment by providing 2,660,400 recreation visitor days.
	5. Changed land use on 1,803 acres of pastureland and 2,494 acres forest land to cropland.
	6. Associated land areas for recreation facilities will occupy 7,200 acres cropland, 2,240 acres pastureland, and 3,560 acres forest land.
	7. Create 100,800 acres of forest lands by afforestation.
	8. Apply 60,000 acres of needed forest land treatment.
	9. Restore 13 miles of degraded stream channel into a more aesthetically pleasing situation.
	10. Establish 41,800 acres of native warm season grasses.
B. Quality considerations of water, land and air resources	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Restore 13 miles of degraded unstable streambanks and channel.
	4. Control erosion on 443,000 acres of lands.
	5. Reduction of 10.83 tons/acre of annual erosion.
C. Biological resources selected ecosystems	1. Permanently inundate 22.4 miles of perennial stream and 13.4 miles of intermittent streams presently supporting warm water stream fisheries with varying populations.

Display #10.--Environmental Quality Account, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
C. Biological resources selected ecosystems (continued)	2. Temporarily inundate at a 2-year frequency 4.8 miles of perennial and 2.4 miles of intermittent streams. At a 50-year frequency, inundation will occur on 17.05 miles of perennial streams and 8.6 miles of intermittent streams.
	3. Permanently inundate 7,710 acres of terrestrial and riparian habitat associated with the reservoir areas of the structures.
	4. Temporarily inundate at a 2-year frequency 1,890 acres terrestrial and riparian habitat. At a 50-year frequency inundation will effect 7,100 acres of habitat.
	5. Create 7,710 acres of lake water fish habitat in the 6,500 acres of recreation pools and 1,210 acres of municipal and industrial water pools.
	6. Provide 7,710 acres of resting areas for waterfowl, of which 1,610 acres will be less than 2 feet deep.
	7. Increase terrestrial habitat of the basin 20-30 percent by the year 2000.
	8. Restore stream habitat on 13 miles of degraded stream channel of Blackwater and Davis Creek.
	9. Provide 25,000 acres of lands to be used primarily for wildlife on public natural areas and stream corridors.
D. Irreversible or irretrievable commitments	1. Changed land use of 4,042 acres of cropland, 1,251 acres pastureland and 2,417 acres of forest land to permanent water.

Display #11.--Regional Development Account, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of increased outputs of goods and services to users residing in the region		
1. Flood prevention	1,580,520	
2. Water supply municipal	129,150	
3. Recreation	851,810	2,763,640
4. Utilization of employment and unemployment labor resources	258,900	
5. Erosion control		
Gully stabilization	272,350	
Streambank	13,250	
6. Environmental Corridors	187,550	

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
A. Value of resources required for a plan		
1. 3 multiple-purpose structures (FP & MI)		
Project Installation	102,310	21,190
OM&R	5,650	
2. 19 multiple-purpose structures (FP & Rec)		
Project Installation	1,112,415	1,340,605
OM&R	1,263,640	
3. Erosion control		
Gully stabilization		
Project Installation	51,660	226,800
OM&R	13,970	
Streambank		
Project Installation	990	128,700
OM&R	7,920	
4. Environmental corridors		
Project Installation	113,090	113,090
5. Project Administration	5,750	392,940

Display #11.--Regional Development Account, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

Income:

BENEFICIAL EFFECTS: Components	Measures of effects 1/ Basin	Rest of nation	ADVERSE EFFECTS: Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)			(Average annual dollars)	
B. The value of output resulting from external economies			B. Losses of output resulting from external diseconomies to users residing in the region		
1. Indirect activities associated with increased net returns from flood prevention and recreation	2,506,590	-2,506,590	1. Indirect activities from reservoir areas	1,169,780	-1,169,780
Total Beneficial Effects	5,800,120	257,050	Total Adverse Effects	3,847,175	1,053,545
Net Beneficial Effects	1,952,945	-796,495			

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $49,436,000. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #11.--Regional Development Account, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS	ADVERSE EFFECTS
Employment:	
Components	Components
A. Increase in the number and types of jobs	A. Decrease in numbers and types of jobs
1. Employment for project construction 154.6 semi-skilled jobs for 10 years	1. Associated with reservoir take areas 74.0 permanent semi-skilled jobs
2. Employment for project OM&R 3.4 permanent semi-skilled jobs	
3. Employment in recreation sector OM&R 89.1 permanent seasonal semi-skilled jobs	
4. Employment in land treatment construction 185.2 semi-skilled jobs for 10 years 10.0 semi-skilled forestry jobs for 10 years 1.0 skilled forester	
5. Employment in land treatment OM&R 48.0 permanent semi-skilled jobs	
6. Employment in externalities 135.1 permanent semi-skilled jobs	
Total Beneficial Effects 349.8 semi-skilled jobs for 10 years 186.5 permanent semi-skilled jobs 89.1 permanent seasonal semi-skilled jobs 1.0 skilled forester	
Net Beneficial Effects 349.8 semi-skilled jobs for 10 years 112.5 permanent semi-skilled jobs 89.1 permanent seasonal semi-skilled jobs 1.0 skilled forester	

Display #12.--Social Well-Being Account, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Create 112.5 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $5,800,120 by income class as follows:
	3. Regional costs of $3,847,175 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoir areas will provide an increased potential of 325,000 fisherman days per year of lake fishing.
	2. Inundation of stream fishing will result in a loss of 2150 fisherman days annually of stream fishing.
	3. Inundation of terrestrial and riparian habitat of reservoir areas will result in a loss of 1284 hunter days annually.
	4. Providing public use areas in association with recreational developments will provide an additional 2512 hunter days annually.
	5. Create 2,410,400 water based recreation visitor days.
	6. Create 250,000 recreation visitor days from environmental corridors.
	7. Restoration of fishing habitat on 13 miles of Blackwater and Davis Creeks will make possible fishing and other associated recreational opportunities.
	8. Enhancement of terrestrial habitat 20-30 percent in basin will make possible more hunting and associated recreational opportunities.

Income distribution under A.2:

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	10
3000 - 10,000	54	45
More than 10,000	32	45

ALTERNATIVE PLANS - BLACKWATER SUBBASIN

The Blackwater Subbasin has a drainage area of 1549.33 square miles at the junction with the Lamine River.

In the headwaters of the Blackwater Subbasin there are two PL-566 watersheds: South Fork of Blackwater River, 102.46 square miles, approved for construction and North Fork-Honey Creek, 97.15 square miles, undergoing detailed planning. These PL-566 watersheds have a proposed drainage area controlled of 95.02 square miles. The downstream effects from this control has been allocated to these watersheds in each of the plans. There are six recreation activities calculated for the three Alternative Plans (Table 87). The total land treatment cost for Alternative Plans A and B is $12,607,700 (Table 88). and for Alternative Plan C it is $32,841,600 (Table 89).

Table 87.--Water Based Recreation Potential Satisfied - Blackwater Subbasin, Blackwater-Lamine River Basin, Missouri

		Alternative Plans		
	Unit	A	B	C
Structures	Number	10	5	11
Surface area	Acres	3,950	1,300	4,350
Basic facilities	Acres	7,900	2,600	8,700
Activities:				
Fishing	Visits	197,500	65,000	217,500
Boating	Visits	412,100	104,600	457,100
Camping	Visits	262,600	104,600	288,600
Picnicking	Visits	412,900	164,250	453,400
Sight seeing	Visits	110,200	35,000	122,700
Swimming	Visits	60,000	0	90,000
Total activities	Visits	1,455,300	472,850	1,629,300
Annual benefits @ 1.50	Dollars	2,182,900	709,250	2,443,900

Table 88.--Land Treatment for Year 2000, Alternative Plans A and B, Blackwater River Subbasin, Blackwater-Lamine River Basin, Missouri

Conservation treatment	Going program: Area treated	Going program: Cost	Accelerated treatment: Area treated	Accelerated treatment: Cost
	-acres-	-dollars-	-acres-	-dollars-
CROPLAND				
Annual cover	400	2,100	300	1,600
Meadow in rotation	3,800	25,300	2,900	19,300
Contour farming	1,900	2,500	1,500	2,000
Terracing, diversions, no till	82,500	3,167,300	63,800	2,450,500
Permanent cover	5,600	147,300	4,300	113,200
Drainage	8,700	57,900	6,700	44,600
Total cropland	102,900		79,500	
Installation cost		3,402,400		2,631,200
Technical assistance		850,600		657,800
Total cropland cost		4,253,000		3,289,000
PASTURE				
Not feasible to treat	100		100	
Protection from overgrazing	4,200	5,600	2,500	3,300
Improvement of cover	41,600	553,300	24,600	327,200
Brush control	1,700	29,400	1,000	17,300
Reestablishment of cover	7,400	196,800	4,300	114,400
Brush control & reestablishment	3,800	116,200	2,200	67,300
Total pasture	58,800		34,700	
Installation cost		901,300		529,500
Technical assistance		225,300		132,400
Total pasture cost		1,126,600		661,900
FOREST				
Reforestation	300	17,400	150	8,400
Timber stand improvement	2,520	113,400	6,360	286,300
Grazing reduction	1,080	37,800	4,820	168,700
Total forest land	3,900		11,330	
Installation cost		168,600		463,400
Technical assistance		62,800		134,700
Total forest cost		231,400		598,100
	-number-		-number-	
GULLY STABILIZATION STRUCTURES	335		1,842	
Installation cost		1,172,500		6,447,000
Technical assistance		293,100		1,611,700
Total gully stabilization cost		1,465,600		8,058,700
TOTAL LAND TREATMENT				
Installation cost		5,644,800		10,071,100
Technical assistance		1,431,800		2,536,600
Total land treatment cost		7,076,600		12,607,700

Display #13.--National Economic Development Account, Blackwater River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Components	Measures of effects 1/ (Average annual dollars)
A. Value to users of increased outputs of goods and services	
1. Flood prevention	1,224,510
2. Water supply municipal	48,960
3. Recreation	2,182,900
4. Utilization of employment and unemployment labor resources	125,800
Total Beneficial Effects	3,582,170
Net Beneficial Effects	1,136,990

ADVERSE EFFECTS

Components	Measures of effects 2/ (Average annual dollars)
A. Value of resources required for the plan	
1. 5 single-purpose flood prevention reservoirs	
Project Installation	121,250
OM&R	5,070
2. 2 multiple-purpose structures (FP & MI)	
Project Installation	46,770
OM&R	2,190
3. 10 multiple-purpose structures (FP & Rec)	
Project Installation	1,344,370
OM&R	749,110
4. Project Administration Structural measures	176,420
Total Adverse Effects	2,445,180

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $12,607,700. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #14.--Environmental Quality Account, Blackwater River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 4,658 acres of permanent water.
	2. Permanent inundation of 2,757 acres of cropland, 626 acres of pastureland, and 1,275 acres of forest land.
	3. Temporary inundation of 4,256 acres of cropland, 933 acres of pastureland and 1,687 acres of forest land.
	4. Disruption in tranquility of rural environment by providing 1,455,300 recreation visitor days.
	5. Changed land use of 1,269 acres of pastureland and 2,559 acres forest land to cropland.
	6. Associated land areas for recreation facilities will occupy 7,900 acres composed of 4,900 acres cropland, 930 acres of pastureland, and 2,070 acres forest land.
	7. 80,565 acres of managed forest land retains natural beauty.
B. Quality considerations of water, land and air resources	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Provides increased quality of water on 80,565 acres.
	4. Reduction in erosion on 34,907 acres of graded forest land.
	5. Reduction in noise and air pollution by establishment of 750 reforested acres.
	6. Reduction of 5.82 tons/acre of annual erosion.
C. Biological resources selected ecosystems	1. Permanently inundate 15 miles of perennial stream and 11 miles of intermittent streams presently supporting warm water stream fisheries with varying populations.

Display #14.--Environmental Quality Account, Blackwater River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
C. Biological resources selected ecosystems (continued)	2. Temporarily inundate at a 2-year frequency 2.5 miles of perennial and 2.5 miles of intermittent stream. At a 50-year frequency inundation will occur on 12.50 miles of perennial stream and 12.0 miles of intermittent stream.
	3. Permanently inundate 4,658 acres of terrestrial and riparian habitat associated with the reservoir areas of the structures.
	4. Temporarily inundate at a 2-year frequency 1,933 acres terrestrial and riparian habitat. At a 50-year frequency inundation will effect 6,876 acres of habitat.
	5. Create 4,658 acres of lake water fish habitat in the 398 acres of sediment pools, 3,950 acres of recreation pools and 310 acres of municipal and industrial water pools.
	6. Provide 4,658 acres of resting areas for waterfowl, of which 1,095 acres will be less than 2 foot deep
	7. 80,565 acres of forest land will be dedicated to wildlife habitat enhancement.
	8. Establishment of 175 acres of black walnut increases food supply for squirrels and other wildlife.
	9. Forest ecosystems are provided on 750 reforested acres.
	10. Temporarily disrupts wildlife habitat during harvest years.
D. Irreversible or irretrievable commitments	1. Changed land use of 2,757 acres of cropland, 626 acres pastureland and 1,275 acres of forest land to permanent water.

Display #15.--Regional Development Account, Blackwater River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS			ADVERSE EFFECTS		
Income:					
Components	Measures of effects 1/ Basin	Measures of effects 1/ Rest of nation	Components	Measures of effects 2/ Basin	Measures of effects 2/ Rest of nation
	(Average annual dollars)			(Average annual dollars)	
A. The value of increased output of goods and services of users residing in the region			A. The value of resources required for a plan		
1. Flood prevention	1,224,510		1. 5 single-purpose flood prevention structures		
			Project Installation	38,750	82,500
			OM&R	5,070	
2. Water supply municipal	48,960		2. 2 multiple-purpose structures (FP & MI)		
			Project Installation	32,120	14,650
			OM&R	2,190	
3. Recreation	430,490	1,752,410	3. 10 multiple-purpose structures (FP & Rec)		
			Project Installation	596,710	747,660
			OM&R	749,110	
4. Utilization of employment and unemployment labor resources	125,800		4. Project Administration Structural measures	1,450	174,970

Display #15.--Regional Development Account, Blackwater River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri (continued)

Income:

BENEFICIAL EFFECTS Components	Measures of effects 1/ Basin	Rest of nation	ADVERSE EFFECTS Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)			(Average annual dollars)	
B. The value of output resulting from external economies			B. Losses of output resulting from external diseconomies to users residing in the region		
1. Indirect activities associated with increased net returns from flood prevention and recreation	1,807,390	-1,807,390	1. Indirect activities from reservoir take areas	832,530	-832,530
Total Beneficial Effects	3,637,150	-54,980	Total Adverse Effects	2,257,930	187,250
Net Beneficial Effects	1,379,220	-242,230			

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $12,607,700. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #15.--Regional Development Account, Blackwater River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS	ADVERSE EFFECTS
Employment:	
Components	Components
A. Increase in the number and types of jobs	A. Decrease in numbers and types of jobs
1. Employment for project construction	1. Associated with reservoir take areas
68.8 semi-skilled jobs for 10 years	52.7 permanent semi-skilled jobs
2. Employment for project OM&R	
1.3 permanent semi-skilled jobs	
3. Employment in recreation sector OM&R	
53.5 permanent seasonal semi-skilled jobs	
4. Employment in land treatment construction	
47.0 semi-skilled jobs for 10 years	
5.0 semi-skilled forestry jobs for 10 years	
.5 skilled forester	
5. Employment in land treatment OM&R	
12.7 permanent semi-skilled jobs	
6. Employment in externalities	
66.4 permanent semi-skilled jobs	
Total Beneficial Effects	
120.8 semi-skilled jobs for 10 years	
80.4 permanent semi-skilled jobs	
53.5 permanent seasonal semi-skilled jobs	
.5 skilled forester	
Net Beneficial Effects	
120.8 semi-skilled jobs for 10 years	
27.7 permanent semi-skilled jobs	
53.5 permanent seasonal semi-skilled jobs	
.5 skilled forester	

Display #16.--Social Well-Being Account, Blackwater River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Create 27.7 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $3,637,150 by income class as follows:
	3. Regional costs of $2,257,930 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoir areas will provide an increased potential of 197,500 fisherman days per year of lake fishing.
	2. Inundation of stream fishing will result in a loss of 1440 fisherman days annually of stream fishing.
	3. Inundation of terrestrial and riparian habitat of reservoir areas will result in a loss of 811 hunter days annually.
	4. Providing public use areas in association with recreational developments will provide an additional 1784 hunter days annually.
	5. Create 1,455,300 recreational visitor days.

Income distribution (item A.2):

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	8
3000 - 10,000	54	44
More than 10,000	32	48

Display #17.--National Economic Development Account, Blackwater River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS Components	Measures of effects 1/ (Average annual dollars)	ADVERSE EFFECTS Components	Measures of effects 2/ (Average annual dollars)
A. Value to users of increased outputs of goods and services		A. Value of resources required for the plan	
1. Flood prevention	1,826,120	1. 46 single-purpose flood prevention reservoirs	
		Project Installation	725,920
		OM&R	33,270
2. Water supply municipal	48,960	2. 2 multiple-purpose structures (FP & MI)	
		Project Installation	46,770
		OM&R	2,190
3. Recreation	709,250	3. 5 multiple-purpose structures (FP & Rec)	
		Project Installation	518,790
		OM&R	249,280
4. Utilization of employment and unemployment labor resources	114,360	4. Levee and drainage	
		Project Installation	220,900
		OM&R	143,620
5. Drainage	74,070	5. Project Administration	
		Structural measures	194,160
Total Beneficial Effects	2,772,760	Total Adverse Effects	2,134,900
Net Beneficial Effects	637,860		

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $12,607,700. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #18.--Environmental Quality Account, Blackwater River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 4,008 acres permanent water.
	2. Permanent inundation of 2,256 acres of cropland, 630 acres of pastureland, and 1,122 acres of forest land.
	3. Temporary inundation of 6,634 acres of cropland, 1,859 acres of pastureland, and 2,893 acres of forest land.
	4. Disruption in tranquility of rural environment by providing 472,850 recreation visitor days.
	5. Levee 13.1 mile long protecting 3,243 acres bottom land.
	6. Changed land use of 1,916 acres of pastureland and 4,138 acres of forest land to cropland.
	7. Associated land areas for recreation facilities will occupy 1,660 acres of cropland, 550 acres pastureland and 390 acres of forest land.
	8. 96,678 acres of managed forest land retains natural beauty.
B. Quality considerations of water, land and air resources	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Provides measured quality of water on 96,678 acres.
	4. Reduction in erosion on 41,889 acres of grazed land.
	5. Reduction in noise and air pollution by establishment of 900 reforested acres.
	6. Reduction of 6.88 tons/acre of annual erosion.
C. Biological resources selected ecosystems	1. Permanently inundate 14 miles intermittent streams presently supporting warm water stream fisheries with varying populations.

Display #18.--Environmental Quality Account, Blackwater River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
C. Biological resources selected ecosystems (continued)	2. Temporarily inundate at a 2-year frequency 3.45 miles of intermittent streams. A 50-year frequency inundation will occur on 15 miles of intermittent stream.
	3. Permanently inundate 4,000 acres of terrestrial and riparian habitat associated with the reservoir areas of the structures.
	4. Temporarily inundate at a 2-year frequency 2,900 acres terrestrial and riparian habitat. At a 50-year frequency inundation will effect 11,500 acres of habitat.
	5. Create 4,008 acres of lake water fisheries in the 2,398 acres of sediment pools, 1,300 acres of recreation pools and 310 acres of municipal and industrial water pools.
	6. Provide 4,000 acres of resting areas for waterfowl, of which 800 acres will be less than 2 foot deep.
	7. 96,678 acres of forest land will be dedicated to wildlife habitat.
	8. Establishment of 300 acres of black walnut increases food supply for squirrels and other wildlife.
	9. Forest ecosystems are provided on 900 reforested acres.
	10. Temporarily disrupts wildlife habitat during harvest years.
D. Irreversible or irretrievable commitments	1. Changed land use of 2,256 acres of cropland, 630 acres of pasture-land and 1,122 acres of forest land to permanent water.

Display #19.--Regional Development Account, Blackwater River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of increased output of goods and services to users residing in the region		
1. Flood prevention	1,826,120	
2. Water supply municipal	48,960	
3. Recreation	170,290	538,960
4. Utilization of employment and unemployment labor resources	114,360	
5. Drainage	74,070	

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of resources required for a plan		
1. 46 single-purpose flood prevention structures		
Project Installation	185,620	540,300
OM&R	33,270	
2. 2 multiple-purpose structures (FP & MI)		
Project Installation	35,570	11,200
OM&R	2,190	
3. 5 multiple-purpose structures (FP & Rec)		
Project Installation	253,025	265,765
OM&R	249,280	
4. Project Administration		
Structural measures	3,100	191,060
5. Levee and drainage		
Project Installation	182,860	33,040
OM&R	143,620	

Display #19.--Regional Development Account, Blackwater River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS			ADVERSE EFFECTS		
Income:					
Components	Measures of effects 1/		Components	Measures of effects 2/	
	Basin	Rest of nation		Basin	Rest of nation
	(Average annual dollars)			(Average annual dollars)	
B. The value of output resulting from external economies			B. Losses of output resulting from external diseconomies to users residing in the region		
1. Indirect activities associated with increased net returns from flood prevention and recreation	1,656,410	-1,656,410	1. Indirect activities from reservoir take areas	614,000	-614,000
Total Beneficial Effects	3,890,210	-1,117,450	Total Adverse Effects	1,702,535	432,365
Net Beneficial Effects	2,187,675	-1,549,815			

1/ Installation cost of accelerated land treatment, including technical assistance, is estimated to be $12,607,700. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #19.--Regional Development Account, Blackwater River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS

Employment:

Components

A. Increase in the number and types of jobs
   1. Employment for project construction
      75.2 semi-skilled jobs for 10 years
   2. Employment for project OM&R
      7.7 permanent semi-skilled jobs
   3. Employment in recreation sector OM&R
      17.7 permanent seasonal semi-skilled jobs
   4. Employment in land treatment construction
      47.0 semi-skilled jobs for 10 years
      5.0 semi-skilled forestry jobs for 10 years
      .5 skilled forester
   5. Employment in land treatment OM&R
      12.7 permanent semi-skilled jobs
   6. Employment in externalities
      27.2 permanent semi-skilled jobs

Total Beneficial Effects
- 127.2 semi-skilled jobs for 10 years
- 47.6 permanent semi-skilled jobs
- 17.7 permanent seasonal semi-skilled jobs
- .5 skilled forester

Net Beneficial Effects
- 127.2 semi-skilled jobs for 10 years
- 8.7 permanent semi-skilled jobs
- 17.7 permanent seasonal semi-skilled jobs
- .5 skilled forester

ADVERSE EFFECTS

Components

A. Decrease in numbers and types of jobs
   1. Associated with reservoir take areas
      38.9 permanent semi-skilled jobs

Display #20.--Social Well-Being Account, Blackwater River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Create 8.7 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $3,890,210 by income class as follows:
	3. Regional costs of $1,702,535 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoir areas will provide an increased potential of 65,000 fisherman days per year of lake fishing.
	2. Inundation of terrestrial and riparian habitat at reservoir areas will result in a loss of 642 hunter days annually.
	3. Providing public use areas in association with recreation developments will provide an additional 572 hunter days annually.
	4. Create 472,850 recreational visitor days.

Distribution table for item A.2:

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	4
3000 - 10,000	54	42
More than 10,000	32	54

Table 89.--Land Treatment for Year 2000, Alternative Plan C, Blackwater River Subbasin, Blackwater-Lamine River Basin, Missouri

Conservation treatment	Going program: Area treated	Going program: Cost	Accelerated treatment: Area treated	Accelerated treatment: Cost
	-acres-	-dollars-	-acres-	-dollars-
CROPLAND				
Annual cover	400	2,100	500	2,700
Meadow in rotation	3,800	25,300	4,400	29,300
Contour farming	1,900	2,500	2,200	2,900
Terracing, diversions, no till	82,500	3,167,300	96,900	3,720,800
Permanent cover	5,600	147,300	6,600	173,900
Drainage	8,700	57,900	10,200	67,800
Establishment of warm season grasses			10,300	360,500
Afforestation			23,700	1,374,600
Total cropland	102,900		154,800	
Installation cost		3,402,400		5,732,500
Technical assistance		850,600		2,037,400
Total cropland cost		4,253,000		7,769,900
PASTURE				
Not feasible to treat	100		100	
Protection from overgrazing	4,200	5,600	2,800	3,700
Improvement of cover	41,600	553,300	27,700	368,400
Brush control	1,700	29,400	1,200	20,700
Reestablishment of cover	7,400	196,800	4,900	130,300
Brush control and reestablishment	3,800	116,200	2,500	76,500
Establishment of warm season grasses			21,300	745,500
Afforestation			39,200	2,273,600
Total pasture	58,800		99,700	
Installation cost		901,300		3,618,700
Technical assistance		225,300		1,904,300
Total pasture cost		1,126,600		5,523,000
FOREST				
Reforestation	300	17,400	300	16,800
Timber stand improvement	2,520	113,400	12,720	572,500
Grazing reduction	1,080	37,800	9,650	337,900
Total forest land	3,900		22,670	
Installation cost		168,600		927,200
Technical assistance		62,800		269,400
Total forest cost		231,400		1,196,600
	-number-		-number-	
GULLY STABILIZATION STRUCTURES	335		2,177	
Installation cost		1,172,500		7,619,500
Technical assistance		293,100		1,904,900
Total gully stabilization cost		1,465,600		9,524,400
			-miles-	
ROADSIDE EROSION CONTROL			1,602	
Installation cost				7,356,400
Technical assistance				1,471,300
Total roadside erosion control cost				8,827,700
LAND TREATMENT				
Installation cost		5,644,800		25,254,300
Technical assistance		1,431,800		7,587,300
Total land treatment cost		7,076,600		32,841,600

Display #21.--National Economic Development Account, Blackwater River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Components	Measures of effects 1/ (Average annual dollars)
A. Value to users of increased outputs of goods and services	
1. Flood prevention	892,770
2. Water supply municipal	48,960
3. Recreation	2,443,900
4. Utilization of employment and unemployment labor resources	163,330
5. Erosion control	
Gully stabilization	272,350
Streambank	13,250
6. Environmental corridors	68,250
Total Beneficial Effects	3,902,810
Net Beneficial Effects	755,970

ADVERSE EFFECTS

Components	Measures of effects 2/ (Average annual dollars)
A. Value of resources required for the plan	
1. 2 multiple-purpose structures (FP & MI)	
Project Installation	46,770
OM&R	2,190
2. 11 multiple-purpose structures (FP & Rec)	
Project Installation	1,499,190
OM&R	838,170
3. Erosion control structures	
63 gully stabilization	
Project Installation	278,460
OM&R	13,970
9 streambank	
Project Installation	129,690
OM&R	7,920
4. Environmental corridors	
Project Installation	82,250
5. Project Administration	
Structural measures	248,230
Total Adverse Effects	3,146,840

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to $32,841,600. Benefits from land treatment were not evaluated monetarily.

2/ Installation cost amortized for 100 years @ 5 5/8 percent interest.

Display #22.--Environmental Quality Account, Blackwater River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 4,660 acres of permanent water.
	2. Permanent inundation of 2,697 acres of cropland, 676 acres of pastureland and 1,287 acres of forest land.
	3. Temporary inundation of 3,117 acres of cropland, 713 acres of pastureland and 1,328 acres of forest land.
	4. Disruption in tranquility of rural environment by providing 1,720,300 recreation visitor days.
	5. Changed land use on 973 acres of pastureland and 1,770 acres of forest land to cropland.
	6. Associated land areas for recreation facilities will occupy 5,450 acres cropland, 1,110 acres of pastureland and 2,140 acres of forest land.
	7. Create 62,900 acres of forest lands by afforestation.
	8. Apply 22,670 acres of needed forest land treatment.
	9. Restore 13 miles of degraded stream channel into more aesthetically pleasing situation.
	10. Establish 31,600 acres of native warm season grasses.
B. Quality considerations of water, land and air resources	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Restore 13 miles of degraded unstable stream channel.
	4. Control erosion on 277,170 acres of lands by applying needed land treatment.
	5. Reduction of 10.93 tons/acre of annual erosion.

Display #22.--Environmental Quality Account, Blackwater River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
C. Biological resource selected ecosystems	1. Permanently inundate 15 miles of perennial stream and 7.0 miles intermittent streams presently supporting warm water stream fisheries with varying populations.
	2. Temporarily inundate at a 2-year frequency 3.6 miles of perennial and 1.4 miles of intermittent stream. At a 50-year frequency inundation will occur on 12.5 miles of perennial flow stream and 5.0 miles of intermittent stream.
	3. Permanently inundate 4,660 acres of terrestrial and riparian habitat associated with the reservoir areas of the structures.
	4. Temporarily inundate at a 2-year frequency 1,400 acres terrestrial and riparian habitat. At a 50-year frequency inundation will effect 5,200 acres of habitat.
	5. Create 4,660 acres of lake water fisheries in the 4,350 acres of recreation pools and 310 acres of municipal and industrial water pools.
	6. Provide 4,660 acres of resting areas for waterfowl. 1,000 acres will be less than 2 foot deep.
	7. Increase terrestrial habitat of the basin 20-30 percent by year 2000 with land treatment measures.
	8. Restore stream habitat of 13 miles of degraded stream channel at Blackwater and Davis Creeks.
	9. Provide 9,100 acres of lands to be used primarily for wildlife in public natural areas and stream corridors.
D. Irreversible or irretrievable commitments	1. Changed land use of 2,697 acres of cropland, 676 acres of pasture-land and 1,287 acres of forest land to permanent water.

Display #23.--Regional Development Account, Blackwater River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of increased output of goods and services to users residing in the region		
1. Flood prevention	892,770	
2. Water supply municipal	48,960	
3. Recreation	503,570	1,940,330
4. Utilization of employment and unemployment labor resources	163,330	
5. Erosion control		
Gully stabilization	272,350	
Streambank	13,250	
6. Environmental corridors	68,250	

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of basin
	(Average annual dollars)	
A. The value of resources required for a plan		
1. 2 multiple-purpose structures (FP & MI)		
Project Installation	34,410	12,360
OM&R	2,190	
2. 11 multiple-purpose structures (FP & Rec)		
Project Installation	725,005	774,185
OM&R	838,170	
3. Erosion control structures		
63 gully stabilization		
Project Installation	51,660	226,800
OM&R	13,970	
9 streambank		
Project Installation	990	128,700
OM&R	7,920	
4. Environmental Corridors		
Project Installation	41,125	41,125
5. Project Administration		
Structural measures	4,900	243,330

Display #23.--Regional Development Account, Blackwater River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
B. The value of output resulting from external economies		
1. Indirect activities associated with increased net returns from flood prevention and recreation	1,667,230	-1,667,230
Total Beneficial Effects	3,629,710	273,100
Net Beneficial Effects	1,066,510	-310,540

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
B. Losses of output resulting from external diseconomies to users residing in the region		
1. Indirect activities from reservoir take areas	842,860	-842,860
Total Adverse Effects	2,563,200	583,640

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $32,841,600. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #23.--Regional Development Account, Blackwater River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS

Employment:

Components

A. Increase in the number and types of jobs
   1. Employment for project construction
      95.7 semi-skilled jobs for 10 years
   2. Employment for project OM&R
      2.0 permanent semi-skilled jobs
   3. Employment in recreation sector OM&R
      59.9 permanent seasonal semi-skilled jobs
   4. Employment in land treatment construction
      118.8 semi-skilled jobs for 10 years
      5.0 semi-skilled jobs for 10 years
      .5 skilled forester
   5. Employment in land treatment OM&R
      32.0 permanent semi-skilled jobs
   6. Employment in externalities
      102.5 permanent semi-skilled jobs

Total Beneficial Effects
      219.5 semi-skilled jobs for 10 years
      136.5 permanent semi-skilled jobs
      59.9 permanent seasonal semi-skilled jobs
      .5 skilled forester

Net Beneficial Effects
      219.5 semi-skilled jobs for 10 years
      83.2 permanent semi-skilled jobs
      59.9 permanent seasonal semi-skilled jobs
      .5 skilled forester

ADVERSE EFFECTS

Components

A. Decrease in numbers and types of jobs
   1. Associated with reservoir take areas
      53.3 permanent semi-skilled jobs

Display #24.--Social Well-Being Account, Blackwater River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Create 83.2 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $3,629,710 by income class as follows:

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	9
3000 - 10,000	54	45
More than 10,000	32	46

COMPONENT	MEASURES OF EFFECTS
	3. Regional costs of $2,563,200 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoir areas will provide an increased potential of 217,500 fisherman days per year of lake fishing.
	2. Inundation of stream fishing will result in a loss of 1440 fisherman days annually of stream fishing.
	3. Inundation of terrestrial and riparian habitat of reservoir areas will result in a loss of 754 hunter days annually.
	4. Providing public use areas in association with recreational developments will provide an additional 1784 hunter days annually.
	5. Create 1,629,300 water based recreational visitor days.
	6. Create 91,000 recreation visitor days from environmental corridors.
	7. Restoration of fishing habitat on 13 miles Blackwater and Davis Creeks will make possible fishing and other associated recreational opportunities.
	8. Enhancement of terrestrial habitat 20-30 percent in basin will make possible more hunting and associated recreational opportunities.

ALTERNATIVE PLANS - LAMINE SUBBASIN

The Lamine River has a drainage area of 1079.66 square miles at the junction of the Blackwater River. There is an additional 30.85 square miles of drainage area below the junction of the Lamine and Blackwater Rivers to the outlet at the Missouri River. The flood plain in this area is effected by the Blackwater and the Missouri River but no benefits have been evaluated for this study. Five recreation activities are calculated for the three Alternative Plans (Table 90). The total land treatment cost for Alternative Plans A and B is $3,807,300 (Table 91) and for Alternative Plan C is $9,567,900 (Table 92).

Table 90.--Water Based Recreation Potential Satisfied - Lamine Subbasin, Blackwater-Lamine River Basin, Missouri

		Alternative Plans		
	Unit	A	B	C
Structures	Number	8	5	8
Surface area	Acre	2,350	1,130	2,150
Basic facilities	Acre	4,100	2,260	4,300
Activities:				
Fishing	Visits	117,500	56,500	107,500
Boating	Visits	187,100	91,800	172,100
Camping	Visits	184,600	96,200	169,000
Picnicking	Visits	291,300	145,560	272,500
Sight seeing	Visits	70,000	30,000	60,000
Total activities	Visits	850,500	420,060	781,100
Annual benefits @ 1.50	Dollars	1,275,650	630,010	1,171,550

Table 91.--Land Treatment for Year 2000, Alternative Plans A and B, Lamine River Subbasin, Blackwater-Lamine River Basin, Missouri

Conservation treatment	Going program: Area treated	Going program: Cost	Accelerated treatment: Area treated	Accelerated treatment: Cost
	-acres-	-dollars-	-acres-	-dollars-
CROPLAND				
Annual cover	2,800	14,900	1,700	9,000
Meadow in rotation	3,400	22,600	2,100	14,000
Contour farming	2,000	2,700	1,200	1,600
Terracing, diversions, no till	57,400	2,547,500	35,000	1,553,000
Permanent cover	700	18,600	400	10,600
Drainage	8,800	58,500	5,400	35,900
Total cropland	75,100		45,800	
Installation cost		2,664,800		1,624,100
Technical assistance		666,200		406,000
Total cropland cost		3,331,000		2,030,100
PASTURE				
Protection from overgrazing	600	800		
Improvement of cover	14,300	190,200	85	1,200
Brush control	500	8,600		
Reestablishment of cover	11,000	292,600	65	1,700
Brush control & reestablishment	8,600	263,100	50	1,500
Total pasture	35,000		200	
Installation cost		755,300		4,400
Technical assistance		188,800		1,100
Total pasture cost		944,100		5,500
FOREST				
Reforestation	2,700	156,600	1,300	75,400
Timber stand improvement	3,480	156,600	8,790	395,300
Grazing reduction	1,920	67,200	8,580	300,300
Total forest land	8,100		18,670	
Installation cost		380,400		771,000
Technical assistance		178,300		230,700
Total forest cost		558,700		1,001,700
	-number-		-number-	
GULLY STABILIZATION STRUCTURES	32		176	
Installation cost		112,200		616,000
Technical assistance		28,000		154,000
Total gully stabilization cost		140,200		770,000
TOTAL LAND TREATMENT				
Installation cost		3,912,700		3,015,500
Technical assistance		1,061,300		791,800
Total land treatment cost		4,974,000		3,807,300

Display #25.--National Economic Development Account, Lamine River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS		ADVERSE EFFECTS	
Components	Measures of effects 1/ (Average annual dollars)	Components	Measures of effects 2/ (Average annual dollars)
A. Value to users of increased outputs of goods and services		A. Value of resources required for the plan	
1. Flood prevention	1,737,400	1. 9 single-purpose flood prevention reservoirs	
		Project Installation	279,780
		OM&R	13,580
2. Water supply municipal	80,190	2. 1 multiple-purpose structure (FP & MI)	
		Project Installation	76,730
		OM&R	3,460
3. Recreation	1,275,650	3. 8 multiple-purpose structures (FP & Rec)	
		Project Installation	956,430
		OM&R	455,950
4. Utilization of employment and unemployment labor resources	115,980	4. Project Administration Structural measures	189,640
Total Beneficial Effects	3,209,220	Total Adverse Effects	1,975,570
Net Beneficial Effects	1,233,650		

1/ Installation cost of accelerated land treatment, including technical assistance, is estimated to be $3,807,300. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #26.--Environmental Quality Account, Lamine River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 4,221 acres of permanent water.
	2. Permanent inundation of 1,761 acres of cropland, 812 acres of pastureland and 1,648 acres of forest land.
	3. Temporary inundation of 2,431 acres of cropland, 1,119 acres of pastureland, and 2,198 acres of forest land.
	4. Disruption of tranquility of rural environment by 850,500 recreation visitor days.
	5. Changed land use of 4,413 acres of pastureland and 3,081 acres of forest land to cropland.
	6. Associated land areas for recreation facilities will occupy 4,100 acres composed of 1,510 acres of cropland, and 1,090 acres of pastureland, and 1,500 acres of forest land.
	7. 72,600 acres of managed forest land retains natural beauty.
B. Quality considerations of water, land and air resources	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Provides increased quality of water.
	4. Reduction in erosion on 62,400 acres of grazed forest land.
	5. Reduction in noise and air pollution.
	6. Reduction of 7.11 tons/acre of annual erosion.
C. Biological resources selected ecosystems	1. Permanently inundate 13.0 miles of perennial stream and 9.0 miles intermittent streams presently supporting warm water stream fisheries with varying populations.

Display #26.--Environmental Quality Account, Lamine River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri (continued)

COMPONENT	BENEFICIAL AND ADVERSE EFFECTS MEASURES OF EFFECTS
C. Biological resources selected ecosystems (continued)	2. Temporarily inundate at a 2-year frequency 2.7 miles of perennial and 2.7 miles of intermittent stream. At a 50-year frequency, inundation will occur on 11 miles of perennial stream and 8.5 miles of intermittent streams.
	3. Permanently inundate 4,200 acres of terrestrial and riparian habitat associated with the reservoir areas of the structures.
	4. Temporarily inundate at a 2-year frequency 1,450 acres terrestrial and riparian habitat. At a 50-year frequency inundation will effect 5,750 acres of habitat.
	5. Create 4,220 acres of lake water fish habitat in the 970 acres of sediment pools, 2,350 acres of recreation pools and 900 acres of municipal and industrial water pools.
	6. Provide 4,200 acres of resting areas for waterfowl, of which 845 acres will be less than 2 foot deep.
	7. 67,400 acres of forest land should be dedicated to wildlife habitat enhancement.
	8. Establishment of 2,600 acres of black walnut increases food supply for squirrels and other wildlife.
	9. Forest ecosystems are provided on 9,600 reforested acres.
	10. Temporarily disrupts wildlife habitat during harvest years.
D. Irreversible of irretrievable commitments	1. Changed land use of 1,761 acres of cropland, 812 acres of pastureland and 1,648 acres of forest land.

Display #27.--Regional Development Account, Lamine River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of increased output of goods and services to users residing in the region		
1. Flood prevention	1,737,400	
2. Water supply municipal	80,190	
3. Recreation	368,550	907,100
4. Utilization of employment and unemployment labor resources	115,980	

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of resource required for a plan		
1. 9 single-purpose flood prevention structures		
Project Installation	59,180	220,600
OM&R	13,580	
2. 1 multiple-purpose structure (FP & MI)		
Project Installation	68,020	8,710
OM&R	3,460	
3. 8 multiple-purpose structures (FP & Rec)		
Project Installation	375,520	580,910
OM&R	455,950	
4. Project Administration		
Structural measures	1,300	188,340

Display #27.--Regional Development Account, Lamine River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri
(continued)

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
B. The value of output resulting from external economies		
1. Indirect activities associated with increased net returns from flood prevention and recreation	1,893,500	-1,893,500
Total Beneficial Effects	4,195,620	-986,400
Net Beneficial Effects	2,807,240	-1,573,590

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
B. Losses of output resulting from external diseconomies to users residing in the region		
1. Indirect activities from reservoir take areas	411,370	-411,370
Total Adverse Effects	1,388,380	587,190

1/ Installation cost of accelerated land treatment, including technical assistance, is estimated to be $3,807,300. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #27.--Regional Development Account, Lamine River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS

Employment:

Components

A. Increase in the number and types of jobs
   1. Employment for project construction
      74.1 semi-skilled jobs for 10 years
   2. Employment for project OM&R
      1.9 permanent seasonal semi-skilled jobs
   3. Employment in recreation sector OM&R
      31.5 permanent seasonal semi-skilled jobs
   4. Employment in land treatment construction
      17.1 semi-skilled jobs for 10 years
      5.0 semi-skilled forester jobs for 10 years
      .5 skilled forester
   5. Employment in land treatment OM&R
      3.8 permanent semi-skilled jobs
   6. Employment in externalities (recreation)
      46.0 permanent semi-skilled jobs

Total Beneficial Effects
   96.2 semi-skilled jobs for 10 years
   51.7 permanent semi-skilled jobs
   31.5 permanent seasonal semi-skilled jobs
   .5 skilled forester

Net Beneficial Effects
   96.2 semi-skilled jobs for 10 years
   25.7 permanent semi-skilled jobs
   31.5 permanent seasonal semi-skilled jobs
   .5 skilled forester

ADVERSE EFFECTS

Components

A. Decrease in numbers and types of jobs
   1. Associated with reservoir take areas
      26.0 permanent semi-skilled

Display #28.--Social Well-Being Account, Lamine River Subbasin, Alternative Plan A, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Create 25.7 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $4,195,620 by income class as follows:

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	6
3000 - 10,000	54	43
More than 10,000	32	51

	3. Regional costs of $1,388,380 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoir areas will provide an increased potential of 117,500 fisherman days per year of lake fishing.
	2. Inundation of stream fishing will result in a loss of 1760 fisherman days annually of stream fishing.
	3. Inundation of terrestrial and riparian habitat at reservoir areas will result in a loss of 674 hunter days annually.
	4. Providing public use areas in association with recreational developments will provide an additional 790 hunter days annually.
	5. Create 850,500 recreation visitor days.

Display #29.--National Economic Development Account, Lamine River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS		ADVERSE EFFECTS	
Components	Measures of effects 1/ (Average annual dollars)	Components	Measures of effects 2/ (Average annual dollars)
A. Value to users of increased outputs of goods and services		A. Value of resources required for the plan	
1. Flood prevention	1,945,580	1. 43 single-purpose flood prevention reservoirs	
		Project Installation	788,050
		OM&R	37,930
2. Water supply municipal	80,190	2. 1 multiple-purpose structure	
		Project Installation	76,730
		OM&R	3,460
3. Recreation	630,010	3. 5 multiple-purpose structures	
		Project Installation	518,760
		OM&R	229,700
4. Utilization of employment and unemployment labor resources	108,020	4. Project Administration Structural measures	200,050
Total Beneficial Effects	2,763,800	Total Adverse Effects	1,854,680
Net Beneficial Effects	909,120		

1/ Installation cost of accelerated land treatment, including technical assistance, is estimated to be $3,807,300. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #30.--Environmental Quality Account, Lamine River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 4,466 acres permanent water.
	2. Permanent inundation of 1,843 acres of cropland, 840 acres of pastureland, and 1,783 acres of forest land.
	3. Temporary inundation of 4,610 acres of cropland, 2,080 acres of pastureland, and 3,837 acres of forest land.
	4. Disruption in tranquility of rural environment by 420,060 recreation visitor days.
	5. Changed land use on 4,739 acres of pastureland and 3,985 acres of forest land to cropland.
	6. Associated land areas for recreation facilities will occupy 818 acres of cropland, 592 acres of pastureland, and 850 acres of forest land.
	7. 87,120 acres of managed forest land retains natural beauty.
B. Quality considerations of water, land and air resources	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Provides increased quality of water.
	4. Reduction in erosion on 74,878 acres of grazed forest land.
	5. Reduction in noise and air pollution.
	6. Reduction of 7.50 tons/acre of annual erosion.
C. Biological resources selected ecosystems	1. Permanently inundate 5.1 miles of perennial stream and 16.5 miles intermittent streams presently supporting warm water stream fisheries with varying populations.

Display #30.--Environmental Quality Account, Lamine River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
C. Biological resources selected ecosystems (continued)	2. Temporarily inundate at a 2-year frequency 1.0 miles of perennial and 3.9 miles of intermittent streams at a 50-year frequency inundation will occur on 4.0 miles of perennial flow stream and 15.5 miles of intermittent stream.
	3. Permanently inundate 4,460 acres of terrestrial and riparian habitat associated with the reservoir areas of the structures.
	4. Temporarily inundate at a 2-year frequency 2,650 acres terrestrial and riparian habitat. At a 50-year frequency inundation will effect 10,500 acres of habitat.
	5. Create 4,466 acres of lake water fisheries in the 2,436 acres of sediment pools, 1,130 acres of recreation pools and 900 acres of municipal and industrial water pools.
	6. Provide 4,466 acres of resting areas for waterfowl, of which 900 acres will be less than 2 foot deep.
	7. 80,880 acres of forest land should be dedicated to wildlife habitat enhancement.
	8. Establishment of 4,142 acres of black walnut increases food supply for squirrels and other wildlife.
	9. Forest ecosystems are provided on 11,542 reforested acres.
	10. Temporarily disrupts wildlife habitat during harvest years.
D. Irreversible or irretrievable commitments	1. Changed land use of 1,843 acres of cropland, 840 acres of pastureland, and 1,783 acres of forest land to permanent water.

Display #31.--Regional Development Account, Lamine River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of increased output of goods and services to users residing in the region		
1. Flood prevention	1,945,580	
2. Water supply municipal	80,190	
3. Recreation	185,230	444,780
4. Utilization of employment and unemployment labor resources	180,020	

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of resources required for a plan		
1. 43 single-purpose flood prevention structures		
Project Installation	172,090	615,960
OM&R	37,930	
2. 1 multiple-purpose structure (FP & MI)		
Project Installation	63,480	13,250
OM&R	3,460	
3. 5 multiple-purpose structures (FP & Rec)		
Project Installation	201,980	316,780
OM&R	180,360	
4. Project Administration		
Structural measures	2,700	197,350

Display #31.--Regional Development Account, Lamine River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS			ADVERSE EFFECTS		
Income:					
Components	Measures of effects 1/		Components	Measures of effects 2/	
	Basin	Rest of nation		Basin	Rest of nation
	(Average annual dollars)			(Average annual dollars)	
B. The value of output resulting from external economies			B. Losses of output resulting from external diseconomies to users residing in the region		
1. Indirect activities associated with increased net returns from flood prevention and recreation	1,776,620	-1,776,620	1. Indirect activities from reservoir take areas	432,420	-432,420
Total Beneficial Effects	4,095,640	-1,331,840	Total Adverse Effects	1,094,420	710,920
Net Beneficial Effects	3,001,220	-2,042,760			

1/ Installation cost of accelerated land treatment, including technical assistance, is estimated to be $3,807,300. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #31.--Regional Development Account, Lamine River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS	ADVERSE EFFECTS
Employment:	
Components	Components
A. Increase in the number and types of jobs	A. Decrease in numbers and types of jobs
1. Employment for project construction 77.6 semi-skilled jobs for 10 years	1. Associated with reservoir take areas 27.4 permanent semi-skilled jobs
2. Employment for project OM&R 2.4 permanent semi-skilled jobs	
3. Employment in recreation sector OM&R 15.7 permanent seasonal semi-skilled jobs	
4. Employment in land treatment construction 17.1 semi-skilled jobs for 10 years 5.0 semi-skilled forestry jobs for 10 years .5 skilled forester	
5. Employment in land treatment OM&R 3.8 permanent semi-skilled jobs	
6. Employment in externalities 20 permanent semi-skilled jobs	
Total Beneficial Effects 99.7 semi-skilled jobs for 10 years 26.2 permanent semi-skilled jobs 15.7 permanent seasonal semi-skilled jobs .5 skilled forester	
Net Beneficial Effects 99.7 semi-skilled jobs for 10 years -1.2 permanent semi-skilled jobs 15.7 permanent seasonal semi-skilled jobs .5 skilled forester	

Display #32.--Social Well-Being Account, Lamine River Subbasin, Alternative Plan B, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Net loss of 1.2 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $4,095,640 by income class as follows:

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	4
3000 - 10,000	54	42
More than 10,000	32	54

	3. Regional costs of $1,094,420 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoir areas will be an increased potential of 56,500 fisherman days per year of lake fishing.
	2. Inundation of terrestrial and riparian habitat at reservoir areas will result in a loss of 722 hunter days annually.
	3. Inundation of stream fishing will result in a loss of 675 fisherman days annually of stream fishing.
	4. Providing public use areas in association with recreation developments will provide an additional 356 hunter days annually.
	5. Create 420,060 recreational visitor days.

Table 92.--Land Treatment for Year 2000, Alternative Plan C, Lamine River Subbasin, Blackwater-Lamine River Basin, Missouri

Conservation treatment	Going program		Accelerated treatment	
	Area treated	Cost	Area treated	Cost
	-acres-	-dollars-	-acres-	-dollars-
CROPLAND				
Annual cover	2,800	14,900	2,500	13,300
Meadow in rotation	3,400	22,600	3,000	20,000
Contour farming	2,000	2,700	1,800	2,400
Terracing, diversions, no till	57,400	2,547,500	51,200	2,271,100
Permanent cover	700	18,600	600	16,000
Drainage	8,800	58,500	7,800	51,900
Establishment of tame grasses			9,400	250,000
Establishment of warm season grasses			4,300	150,500
Afforestation			13,000	754,000
Total cropland	75,100		93,600	
Installation cost		2,664,800		3,529,200
Technical assistance		666,200		1,213,800
Total cropland cost		3,331,000		4,743,000
PASTURE				
Protection from overgrazing	600	800		
Improvement of cover	14,300	190,200		
Brush control	500	8,600		
Reestablishment of cover	11,000	292,600		
Brush control and reestablishment	8,600	263,100		
Establishment of tame grasses			3,700	98,400
Establishment of warm season grasses			5,900	206,500
Afforestation			24,900	1,444,200
Total pasture	35,000		34,900	
Installation cost		755,300		1,749,100
Technical assistance		188,800		1,072,200
Total pasture cost		944,100		2,821,300
FOREST				
Reforestation	2,700	156,600	2,600	150,800
Timber stand improvement	3,480	156,600	17,570	790,700
Grazing reduction	1,920	67,200	17,160	600,700
Total forest land	8,100		37,330	
Installation cost		380,400		1,542,200
Technical assistance		178,300		461,400
Total forest cost		558,700		2,003,600
TOTAL LAND TREATMENT				
Acres	118,200		165,830	
Installation cost		3,800,500		6,820,500
Technical assistance		1,033,300		2,747,400
Total land treatment cost		4,833,800		9,567,900
	-number-		-number-	
GULLY STABILIZATION STRUCTURES	32		208	
Installation cost		112,200		728,000
Technical assistance		28,000		182,000
Total gully stabilization cost		140,200		910,000
			-miles-	
ROADSIDE EROSION CONTROL			1,110	
Installation cost				5,097,100
Technical assistance				1,019,400
Total roadside erosion control cost				6,116,500
GRAND TOTAL				
Installation cost		3,912,700		12,645,600
Technical assistance		1,061,300		3,948,800
Total cost		4,974,000		16,594,400

Display #33.--National Economic Development Account, Lamine River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS		ADVERSE EFFECTS	
Components	Measures of effects 1/ (Average annual dollars)	Components	Measures of effects 2/ (Average annual dollars)
A. Value to users of increased outputs of goods and services		A. Value of resources required for the plan	
1. Flood prevention	687,750	1. 1 multiple-purpose structure (FP & MI)	
		Project Installation	76,730
		OM&R	3,460
2. Water supply municipal	80,190	2. 8 multiple-purpose structures (FP & Rec)	
		Project Installation	953,830
		OM&R	425,470
3. Recreation	1,171,550	3. Environmental Corridors	
		Project Installation	143,930
4. Utilization of employment and unemployment labor resources	95,570	4. Project Administration Structural measures	150,460
5. Environmental corridors	119,300		
Total Beneficial Effects	2,154,360	Total Adverse Effects	1,753,880
Net Beneficial Effects	400,480		

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $16,594,400. Benefits from land treatment were not evaluated monetarily.

2/ Installation costs amortized for 100 years @ 5 5/8 percent interest.

Display #34.--Environmental Quality Account, Lamine River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Areas of natural beauty	1. Create 3,050 acres of permanent water.
	2. Permanent inundation of 1,345 acres of cropland, 575 acres of pastureland, and 1,130 acres of forest land.
	3. Temporary inundation of 831 acres of cropland, 368 acres of pastureland, and 706 acres of forest land.
	4. Disruption in tranquility of rural environment by 940,100 recreation visitor days.
	5. Changed land use on 830 acres of pastureland, and 724 acres of forest land to cropland.
	6. Associated land areas for recreation facilities will occupy 1,750 acres cropland, 1,130 acres of pastureland, and 1,420 acres of forest land.
	7. Create 37,900 acres of forest land.
	8. Apply 37,330 acres of needed forest land.
	9. Establish 10,200 acres of native warm season grasses.
B. Quality considerations of water, land and air resources	1. Improve quality of water in streams below structures.
	2. Reduce sediment deposition on flood plains below structures.
	3. Control erosion on 165,830 acres of lands by applying needed land treatment.
	4. Reduction of 10.68 tons/acre of annual erosion.
C. Biological resources selected ecosystems	1. Permanently inundate 7.4 miles of perennial stream and 6.4 miles intermittent streams presently supporting warm water stream fisheries with varying populations.

Display #34.--Environmental Quality Account, Lamine River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
C. Biological resources selected ecosystems	2. Temporarily inundate at a 2-year frequency 1.2 miles of perennial and 1.0 miles of intermittent stream. At a 50-year frequency, inundation will occur on 4.55 miles of perennial flow stream and 3.6 miles of intermittent stream.
	3. Permanently inundate 3,050 acres of terrestrial and riparian habitat associated with the reservoir areas of the structures.
	4. Temporarily inundate at a 2-year frequency 490 acres terrestrial and riparian habitat. At a 50-year frequency inundation will effect 1,900 acres of habitat.
	5. Create 3,050 acres of lake water fisheries in the 2,150 acres of recreation pools and 900 acres of municipal and industrial water pools.
	6. Provide 3,050 acres of resting areas for waterfowl. 610 acres will be less than 2 foot deep.
	7. Increase terrestrial habitat of the basin 20-30 percent by the year 2000 with land treatment measures.
	8. Provide 15,900 acres of lands to be used primarily for wildlife in public natural areas and stream corridors.
D. Irreversible or irretrievable commitments	1. Changed land use of 1,345 acres of cropland, 575 acres of pastureland and 1,130 acres of forest land to permanent water.

Display #35.--Regional Development Account, Lamine River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL EFFECTS

Income:

Components	Measures of effects 1/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of increased output of goods and services to users residing in the region		
1. Flood prevention	687,750	
2. Water supply municipal	80,190	
3. Recreation	348,240	823,310
4. Utilization of employment and unemployment labor resources	95,570	
5. Environmental corridors	119,300	

ADVERSE EFFECTS

Components	Measures of effects 2/ Basin	Rest of nation
	(Average annual dollars)	
A. The value of resources required for a plan		
1. 1 multiple-purpose structure (FP & MI)		
Project Installation	67,900	8,830
OM&R	3,460	
2. 8 multiple-purpose structures (FP & Rec)		
Project Installation	387,410	566,420
OM&R	425,470	
3. Environmental corridors		
Project Installation	71,965	71,965
4. Project Administration		
Structural measures	850	149,610

Display #35.--Regional Development Account, Lamine River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS			ADVERSE EFFECTS		
Income:					
Components	Measures of effects 1/		Components	Measures of effects 2/	
	Basin	Rest of nation		Basin	Rest of nation
	(Average annual dollars)			(Average annual dollars)	
B. The value of output resulting from external economies			B. Losses of output resulting from external diseconomies to users residing in the region		
1. Indirect activities associated with increased net returns from flood prevention and recreation	839,360	-839,360	1. Indirect activities from reservoir take areas	326,920	-326,920
Total Beneficial Effects	2,170,410	-16,050	Total Adverse Effects	1,283,975	469,945
Net Beneficial Effects	886,435	-485,955			

1/ Installation costs of accelerated land treatment, including technical assistance, is estimated to be $16,594,400. Benefits from land treatment were not evaluated monetarily.

2/ Installation cost amortized for 100 years @ 5 5/8 percent interest.

Display #35.--Regional Development Account, Lamine River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri (continued)

BENEFICIAL EFFECTS

Employment:

Components

A. Increase in the number and types of jobs
   1. Employment for project construction
      58.9 semi-skilled jobs for 10 years
   2. Employment for project OM&R
      1.4 permanent semi-skilled jobs
   3. Employment in recreation sector OM&R
      29.2 permanent seasonal semi-skilled jobs
   4. Employment in land treatment construction
      66.4 semi-skilled jobs for 10 years
      5.0 semi-skilled forestry jobs for 10 years
      .5 skilled forester
   5. Employment in land treatment OM&R
      16.0 permanent semi-skilled jobs
   6. Employment in externalities
      32.6 permanent semi-skilled jobs

Total Beneficial Effects
- 130.3 semi-skilled jobs for 10 years
- 50.0 permanent semi-skilled jobs
- 29.2 permanent seasonal semi-skilled jobs
- .5 skilled forester

Net Beneficial Effects
- 130.3 semi-skilled jobs for 10 years
- 29.3 permanent semi-skilled jobs
- 29.2 permanent seasonal semi-skilled jobs
- .5 skilled forester

ADVERSE EFFECTS

Components

A. Decrease in numbers and types of jobs
   1. Associated with reservoir take areas
      20.7 permanent semi-skilled jobs

Display #36.--Social Well-Being Account, Lamine River Subbasin, Alternative Plan C, Blackwater-Lamine River Basin, Missouri

BENEFICIAL AND ADVERSE EFFECTS

COMPONENT	MEASURES OF EFFECTS
A. Real income distribution	1. Create 29.3 low to medium income permanent jobs for area residents.
	2. Created regional income benefit distribution of $2,170,410 by income class as follows:
	3. Regional costs of $1,283,975 to be borne in about the same proportion as the benefits accrue.
B. Recreation opportunities	1. Creation of reservoirs will provide an increased potential of 107,500 fisherman days per year of lake fishing.
	2. Inundation of stream fishing will result in a loss of 710 fisherman days annually of stream fishing.
	3. Inundation of terrestrial and riparian habitat of reservoir areas will result in a loss of 530 hunter days annually.
	4. Providing public use areas in association with recreational developments will provide an additional 728 hunter days annually.
	5. Create 940,100 water based recreational visitor days.
	6. Create 159,000 recreation visitor days from environmental corridors.
	7. Enhancement of terrestrial habitat 20-30 percent in basin with land treatment program will make possible more hunting and associated recreational opportunities.

Income class (dollars)	Percent of adjusted gross income in class	Percent benefits in class
Less than 3000	14	10
3000 - 10,000	54	46
More than 10,000	32	44

CHAPTER VI

Comparison of Alternative Plans

COMPARISON OF ALTERNATIVE PLANS

This Chapter compares the physical and monetary effects of Alternative Plans A, B and C. A selected plan was not formulated for this report.

LAND USE AND TREATMENT

The Conservation Needs Inventory is the basic data used for land use projections and treatment needs. The land treatment, recommended in Alternative Plans A, B and C, is designed to accelerate the "going land treatment program" (1) to achieve a high level of erosion and sediment reduction, (2) to maintain the productive capacity to meet the food and fiber needs, (3) to enhance wildlife and (4) to improve the environmental characteristics of the landscape.

Based on present land use, the "going program", projected to the year 2000, will treat 50 percent of the cropland and pastureland and about 23 percent of the forest land. The accelerated land treatment programs in Plans A and B will provide accelerated technical assistance to treat an additional 125,300 acres of cropland, 34,900 acres of pastureland and 30,000 acres of forest land. This would bring the level of land adequately treated to 65 percent, 58 percent and 38 percent, respectively.

Plan C provides for land treatment in excess of the "going program" on 248,400 acres of cropland, 134,600 acres of pastureland and 60,000 acres of forest land. The application of this accelerated land treatment would increase the adequately treated land to 80 percent of the cropland, 82 percent of the pastureland and 54 percent of forest land needs.

An estimated 3,670 gully stabilization structures would be installed as a part of the land treatment program. Over 90 percent of these structures are in the Blackwater Subbasin. An estimated 367 structures would be installed under the going program. Alternative Plans A and B proposes the installation of 2,018 or 65 percent of the need, while Alternative Plan C, proposes 2,385 or 75 percent of the need for gully stabilization structures.

Alternative Plan C encourages major land use shifts in Class IV, VI and provides for establishment of 13,100 acres in tame grasses and 41,800 acres in warm season grasses. This plan also recommends the conversion of 36,700 acres of cropland and 64,100 acres of pastureland to forest land. Erosion control measures are recommended on 2,712 miles of gravel and dirt roads to reduce erosion and sediment production.

Assuming that landowners will have the economic incentive to shift land uses, the 1970 land use without project development is projected to change for the year 2000 in order to satisfy agricultural and other needs (Table 93). The remaining acres to be treated changes with the shift in land use. Also the extent to which the recommended land treatment practices are implemented have a bearing on meeting the demands for food and fiber.

The total accelerated land treatment installation cost for Plans A and B is estimated at $16,415,000 and Plan C is $49,436,000 (Table 94).

Table 93.--Land Treatment-Comparison of Alternative Plans A, B and C, Blackwater-Lamine River Basin, Missouri

Land Use	Without project			Accelerated treatment				Alternative Plans A & B	Alternative Plan C
				Alternative Plans A & B		Alternative Plan C		Projected land use year 2000	
	Present 1970	Adequate treated	Going program	Provides	Remain. 1/	Provides	Remain. 1/		
	acres								
Total Basin									
Cropland	846,800	247,100	178,000	125,300	303,600	248,400	180,500	854,000	793,300
Pasture	423,300	117,800	93,800	34,900	162,500	134,600	86,800	409,000	368,900
Forest	297,700	33,800	12,000	30,000	144,200	60,000	114,200	220,000	320,800
Other	44,300							43,700	43,700
Total inventory	1,612,100	398,700	283,800	190,200	610,300	443,000	381,500	1,526,700	1,526,700
Non-inventory	90,200							175,600	175,600
Total Basin	1,702,300							1,702,300	1,702,300
Blackwater River Subbasin									
Cropland	541,400	169,500	102,900	79,500	112,100	154,800	36,800	464,000	
Pasture	231,100	56,700	58,800	34,700	151,800	99,700	86,800	302,000	
Forest	140,700	16,000	3,900	11,330	65,770	22,670	54,430	97,000	
Other	22,600							22,300	
Total inventory	935,800	242,200	165,600	125,530	329,670	277,170	178,030	885,300	
Non-inventory	55,800							106,300	
Total Blackwater Subbasin	991,600							991,600	
Lamine River Subbasin									
Cropland	305,400	77,600	75,100	45,800	191,500	93,600	143,700	390,000	
Pasture	192,200	61,100 2/	35,000	200	10,700	34,900	0	107,000	
Forest	157,000	17,800	8,100	18,670	78,430	37,330	59,770	123,000	
Other	21,700							21,400	
Total inventory	676,300	156,500	118,200	64,670	280,630	165,830	203,470	641,400	
Non-inventory	34,400							69,300	
Total Lamine Subbasin	710,700							710,700	

1/ Remaining acres are the difference between acres treated and projected land use for year 2000.

2/ 24,000 acres needs accelerated treatment under Alternative Plan C to meet goals.

Table 94.--Land Treatment Costs for the Year 2000, Alternative Plans A, B and C, Blackwater-Lamine River Basin, Missouri

Conservation treatment	Going program		Accelerated treatment: Alternative Plans A and B		Accelerated treatment: Alternative Plan C	
	-unit-	-dollars-	-unit-	-dollars-	-unit-	-dollars-
Total Basin						
Land treatment	283,800 Ac.	8,272,800	190,200 Ac.	6,023,600	443,000 Ac.	17,098,900
Gully stabilization structures	367 No.	1,284,700	2,018 No.	7,063,000	2,385 No.	8,347,500
Roadside erosion control					2,712 Mi.	12,453,500
Total installation cost		9,557,500		13,086,600		37,899,900
Technical assistance		2,493,100		3,328,400		11,536,100
Total cost		12,050,600		16,415,000		49,436,000
Blackwater River Subbasin						
Land treatment	165,600 Ac.	4,472,300	125,530 Ac.	3,629,100	277,170 Ac.	10,278,400
Gully stabilization structures	335 No.	1,172,500	1,842 No.	6,447,000	2,117 No.	7,619,500
Roadside erosion control					1,602 Mi.	7,356,400
Total installation cost		5,644,800		10,071,100		25,254,300
Technical assistance		1,431,800		2,536,600		7,587,300
Total cost		7,076,600		12,607,700		32,841,600
Lamine River Subbasin						
Land treatment	118,200 Ac.	3,800,500	64,670 Ac.	2,399,500	165,830 Ac.	6,820,500
Gully stabilization structures	32 No.	112,200	176 No.	616,000	208 No.	728,000
Roadside erosion control					1,110 Mi.	5,097,100
Total installation cost		3,912,700		3,015,500		12,645,600
Technical assistance		1,061,300		791,800		3,948,800
Total cost		4,974,000		3,807,300		16,594,400

EROSION AND SEDIMENT

The annual yield of erosion and sediment is measured in tons of soil loss. Total annual gross erosion from sheet, gully, flood plain scour, streambank erosion and road ditches was over 21,000,000 tons under present conditions (Table 95). Gross erosion is expected to be reduced from 12.54 tons per acre to 6.12 tons per acre for Plan A, 5.40 for Plan B and 1.71 for Plan C. The tons of sediment leaving the watershed can be reduced from the present condition of 3.21 tons/acre to 1.63 tons/acre for Plan A and 0.74 tons/acre for Plan C.

PHYSICAL AND MONETARY COMPARISON OF ALTERNATIVE PLANS

The Blackwater Subbasin contains two watersheds which have been planned under PL-566. The South Fork Blackwater River and the North Fork Blackwater-Honey Creek contain 219.52 square miles of drainage area in the headwaters of the Blackwater Subbasin. For the purpose of determining downstream effects, a total of 95.02 square miles of these watersheds was assumed to be controlled in all 3 alternatives.

Alternative Plan A proposes a total of 35 single and multiple purpose structures controlling 34 percent of the basin for flood prevention (Table 96). Alternative Plan B has 102 single and multiple purpose structures controlling 39 percent of the basin. Also 13 miles of levees are proposed in the Upper Blackwater Watershed to help alleviate flooding.

Alternative Plan C has 22 multiple purpose structures with flood storage controlling 24 percent of the area. This plan also includes 63 erosion control structures to reduce severe erosion and soil loss along the mainstem of the Blackwater River. Nine streambank erosion control structures with low rock fill across the channel and restoration of streambank vegetation are proposed to reduce velocities, bank sloughing and bottom degradation. These improvements will enhance the environmental characteristics of the stream by creating alternative pool areas and riffle sections for fish and wildlife habitat.

Environmental corridors are proposed for 25,000 acres with 40 miles of stream channels. These are the highest rated corridors in the basin and should have first priority in preserving the ecological qualities of these stream reaches.

Total projected floodwater damages are $4,488,060 on 113,370 flood plain acres. Flood prevention benefits in Alternative Plan A, including more intensive and changed land use benefits, amount to $2,961,910 or 43 percent of the total estimated benefits of $6,791,390 (Table 97). In Alternative Plan B flood prevention benefits of $3,771,700, account for 68 percent of $5,536,650 of total benefits.

Alternative Plan C will provide flood prevention benefits of $1,580,520 or 26 percent of $6,057,170 of total benefits

Total installation costs for all project measures amount to $50,014,760 for Plan A, $47,744,970 for Plan B, and $56,835,410 for Plan C (Table 98).

Table 95.--Annual Erosion and Sediment Yield at Watershed Outlets for the Year 2000, Blackwater-Lamine River Basin, Missouri

Items	Gross erosion					Sediment yield at watershed outlets				
			Alternative Plans					Alternative Plans		
	Present	Going Program	A	B	C	Present	Going Program	A	B	C
	thousand tons									
TOTAL BASIN										
Sheet erosion	15,723	11,149	7,545	6,471	1,583	931	662	463	406	97
Gully	2,376	1,777	1,134	1,019	250	1,856	1,333	852	766	190
Flood plain scour	1,513	1,512	758	672	1,079	1,361	1,360	682	605	972
Accelerated channel	444	318	300	296	0	422	302	285	281	0
Roads and ditches	1,185	1,185	785	733	0	889	889	591	553	0
Total tons	21,341	15,941	10,522	9,191	2,912	5,459	4,547	2,873	2,611	1,259
Volume - Acre feet	11.9	8.9	5.9	5.1	1.6	3.0	2.5	1.6	1.5	0.7
Tons/square mile	8.0	6.0	3.9	3.5	1.1	2.1	1.7	1.0	1.0	0.5
Tons/acre (actual value)	12.54	9.36	6.12	5.40	1.71	3.21	2.67	1.63	1.53	0.74
BLACKWATER SUBBASIN										
Sheet erosion	9,141	6,241	4,783	3,940	960	503	343	272	229	55
Gully	1,522	1,069	759	651	160	1,141	802	570	489	123
Flood plain scour	855	855	514	443	608	769	769	463	399	548
Accelerated channel	444	318	300	296	0	422	302	285	281	0
Roads and ditches	608	608	439	414	0	456	456	330	312	0
Total tons	12,570	9,091	6,795	5,744	1,728	3,291	2,673	1,920	1,710	726
Volume - Acre feet	7.0	5.1	3.8	3.2	1.0	1.8	1.5	1.1	1.0	0.4
Tons/square mile	8.1	5.9	4.4	3.7	1.1	2.1	1.7	1.2	1.1	0.5
Tons/acre (actual value)	12.67	9.16	6.85	5.79	1.74	3.32	2.69	1.94	1.72	0.73
LAMINE SUBBASIN										
Sheet erosion	6,582	4,908	2,762	2,531	623	428	319	191	177	42
Gully	954	708	375	368	90	715	531	282	277	67
Flood plain acour	658	657	244	229	471	592	591	219	206	424
Roads and ditches	577	577	346	319	0	433	433	261	241	0
Total tons	8,771	6,850	3,727	2,447	1,184	2,168	1,874	953	901	533
Volume - Acre feet	4.9	3.8	2.1	1.9	0.6	1.2	1.0	0.5	0.5	0.3
Tons/square mile	7.9	6.2	3.4	3.1	1.1	2.0	1.7	0.9	0.8	0.5
Tons/acre (actual value)	12.35	9.64	5.24	4.85	1.67	3.05	2.64	1.34	1.27	0.75

Table 96.--Comparison of Structural Measures by Alternative Plans, Blackwater-Lamine River Basin, Missouri

Alternative Plans	Drainage area	Drainage area controlled		Flood prevention	Flood prevention municipal water	Flood prevention recreation	Stabilization structures	Streambank control structures	Levees and drainage	Environmental corridors
	--- square mile ---		-percent-	- - - - - -	- - - -	- number -	- - - -	- - - -	---- miles/acres ----	
Total Basin										
A	2659.84	910.88	34	14	3	18				
B	2659.84	1047.13	39	89	3	10			13/3243	
C	2659.84	627.50	24	0	3	19	63	9		40/25,000
Blackwater Subbasin 1/										
A	1549.33	465.45	30	5	2	10				
B	1549.33	543.56	35	46	2	5			13/3243	
C	1549.33	412.76	27	0	2	11	63	9		17/9100
Lamine Subbasin 2/										
A	1079.66	445.43	41	9	1	8				
B	1079.66	503.57	47	43	1	5				
C	1079.66	214.74	20	0	1	8				23/15,900

1/ The Blackwater Subbasin includes a drainage area of 219.52 square miles in South Fork Blackwater and North Fork-Honey Creek PL-566 watersheds with 95.02 square miles controlled for downstream analysis.

2/ The drainage area for percent control is the junction of Lamine River and Blackwater River. Total drainage area of Lamine River Subbasin is 1110.51 square miles.

Table 97.--Structural Measures - Comparison of Annual Benefits by Alternative Plans, Blackwater-Lamine River Basin, Missouri

Area	Alternative Plans		
	Plan A	Plan B	Plan C
	- - - - - - - -	dollars - - - - - - - -	
TOTAL BASIN			
Flood prevention	2,961,910	3,771,700	1,580,520
Water supply municipal	129,150	129,150	129,150
Recreation	3,458,550	1,339,260	3,615,450
Drainage		74,070	
Gully stabilization			272,350
Streambank			13,250
Environmental corridors			187,550
Utilization of employment and unemployment labor resources	241,780	222,380	258,900
Total Beneficial Effects	6,791,390	5,536,560	6,057,170
Net Beneficial Effects	2,370,640	1,546,980	1,156,450
BLACKWATER SUBBASIN			
Flood prevention	1,224,510	1,826,120	892,770
Water supply municipal	48,960	48,960	48,960
Recreation	2,182,900	709,250	2,443,900
Drainage		74,070	
Gully stabilization			272,350
Streambank			13,250
Environmental corridors			68,250
Utilization of employment and unemployment labor resources	125,800	114,360	163,330
Total Beneficial Effects	3,582,170	2,772,760	3,902,810
Net Beneficial Effects	1,136,990	637,860	755,970
LAMINE SUBBASIN			
Flood prevention	1,737,400	1,945,580	687,750
Water supply municipal	80,190	80,190	80,190
Recreation	1,275,650	630,010	1,171,550
Environmental corridors			119,300
Utilization of employment and unemployment labor resources	115,900	108,020	95,570
Total Beneficial Effects	3,209,220	2,763,800	2,154,360
Net Beneficial Effects	1,233,650	909,120	400,480

Table 98.--Total Structural Measures-Installation Cost by Alternative Plans, Blackwater-Lamine River Basin, Missouri

Installation cost item	Alternative Plans A	B	C
	dollars		
TOTAL BASIN			
Construction	31,068,870	31,011,780	33,603,480
Engineering	4,660,330	4,650,120	5,040,550
Land easement	14,285,560	12,083,070	18,191,380
Installation	50,014,760	47,744,970	56,835,410
BLACKWATER SUBBASIN			
Construction	14,962,310	14,134,280	20,808,990
Engineering	2,244,650	2,118,170	3,121,620
Land easement	9,565,770	7,000,750	12,117,530
Installation	26,772,730	23,253,200	36,048,140
LAMINE SUBBASIN			
Construction	16,106,560	16,877,500	12,794,490
Engineering	2,415,680	2,531,950	1,918,930
Land easement	4,719,790	5,082,320	6,073,850
Installation	23,242,030	24,491,770	20,787,270

The average annual costs plus operation and maintenance for Plan A is $4,420,750, Plan B $3,989,580 and Plan C $4,900,720 (Table 99).

The net beneficial effects after deducting the average annual costs results in $2,370,640 for Alternative Plan A, $1,546,980 for Alternative Plan B, and $1,156,450 for Alternative Plan C.

A summary of the average annual benefits by Alternative Plans for the basin and subbasin is given in Table 97. The total monetary beneficial effects for the basin amounts to $6,791,390 for Alternative Plan A, $5,536,560 for Alternative Plan B, and $6,057,170 for Alternative Plan C.

The net beneficial effects after deducting the average annual costs results in $2,370,640 for Plan A, $1,546,980 for Plan B, and $1,156,450 for Plan C.

WATER BASED RECREATION

Alternative Plan A provides for 2,305,800 recreation visits annually (Table 100). A combined total of 6,300 surface acres of water is provided in 18 multi-purpose structures (Table 101). In addition to the reservoir area, 12,000 acres of land is proposed for basic recreational facilities. This plan supplies about 30 percent of the recreational demand in the basin.

Alternative Plan B provides for 892,910 recreation visits or about 12 percent of the recreational demand with 10 multi-purpose structures. The combined surface area of water amounts to 2,430 acres with an additional 4,860 acres for adjacent basic facilities.

Table 99.--Structural Measures-Annual Cost by Alternative Plans, Blackwater-Lamine River Basin, Missouri

	Unit	Plan A	Plan B	Plan C
Flood prevention structure	number	14	89	0
Installation cost	dollars	401,030	1,513,970	0
OM&R	dollars	18,650	71,200	0
Total	dollars	419,680	1,585,170	0
Multiple purpose structure (FP & MI)	number	3	3	3
Installation cost	dollars	123,500	123,500	123,500
OM&R	dollars	5,650	5,650	5,650
Total	dollars	129,150	129,150	129,150
Multiple purpose structure (FP & Rec)	number	18	10	19
Installation cost	dollars	2,300,800	1,037,550	2,453,020
OM&R	dollars	1,205,060	478,980	1,263,640
Total	dollars	3,505,860	1,516,530	3,716,660
Levee and drainage	mile	0	13	0
Installation cost	dollars	0	220,900	0
OM&R	dollars	0	143,620	0
Total	dollars	0	364,520	0
Gully stabilization structure	number	0	0	63
Installation cost	dollars	0	0	278,460
OM&R	dollars	0	0	13,970
Total	dollars	0	0	292,430
Streambank control structure	number	0	0	9
Installation cost	dollars	0	0	129,690
OM&R	dollars	0	0	7,920
Total	dollars	0	0	137,610
Environmental corridors	acres	0	0	25,000
Installation cost	dollars	0	0	226,180
Project administration Structural measures	dollars	366,060	394,210	398,690
Total	dollars	4,420,750	3,989,580	4,900,720

Alternative Plan C provides for 2,410,400 recreation visits or about 32 percent of the recreation demand with 20 multi-purpose structures. These structures would provide 6500 surface acres of water plus an additional 13,000 acres of land in adjacent recreation basic facilities.

Sixty-nine percent of the basin's recreation demand is in the Blackwater Subbasin largely because of it's close proximity to Kansas City. Fishing is one of the key activities associated with water based recreation.

Estimated annual recreation benefits from the proposed multi-purpose structures are $3,458,550 for Alternative Plan A, $1,339,260 for Alternative Plan B, and $3,615,450 for Alternative Plan C.

Table 100.--Water Based Recreational Demand Met by Alternative Plans, Blackwater-Lamine River Basin, Missouri

Activities	Total demand year 2000	Existing supply	Recreation needs	Alternative Plans					
				A		B		C	
				Provides	Remaining	Provides	Remaining	Provides	Remaining
	visits								
Fishing	1,057,830	272,550	785,280	315,000	470,280	121,500	663,780	325,000	460,280
Boating	1,229,540	none	1,229,540	599,200	630,340	196,400	1,033,140	629,200	600,340
Camping	1,228,490	62,400	1,226,090	447,200	778,890	200,200	1,025,890	457,600	768,490
Picnicking	871,120	324,000	547,120	704,200	none	309,810	237,310	725,900	none
Sightseeing	3,096,090	none	3,096,090	180,200	2,915,890	65,000	3,031,090	182,700	2,913,390
Swimming	876,050	176,450	699,600	60,000	639,600	none	699,600	90,000	609,600
TOTAL	8,419,120	835,400	7,583,720	2,305,800	5,277,920	892,910	6,690,810	2,410,400	5,173,320
Annual Benefits				$3,458,550		$1,339,260		$3,615,450	

Table 101.--Structural Measures for Recreation by Alternative Plans, Blackwater-Lamine River Basin, Missouri

Measures	Unit	Alternative Plans A	B	C
TOTAL BASIN				
Structures	number	18	10	19
Surface area	acres	6,300	2,430	6,500
Basic facilities	acres	12,000	4,860	13,000
BLACKWATER SUBBASIN				
Structures	number	10	5	11
Surface area	acres	3,950	1,300	4,350
Basic facilities	acres	7,900	2,600	8,700
LAMINE SUBBASIN				
Structures	number	8	5	8
Surface areas	acres	2,350	1,130	2,150
Basic facilities	acres	4,100	2,260	4,300

MUNICIPAL WATER SUPPLY

Water supplies for the communities of Sedalia, Higginsville and Sweet Springs are included in all Alternative Plans. Total annual benefits for these three municipal water supplies amount to $129,150 which is based on the cost of the cheapest most likely alternative source.

ENVIRONMENTAL CORRIDOR

The monetary effects of the environmental corridor development is measured in environmental recreation visits. Alternative Plan C will supply 250,000 environment recreation visits annually with an annual value of $187,550. The average annual costs are estimated at $235,800 for easements of 25,000 acres.

CHAPTER VII

Opportunities for Development of USDA Programs

OPPORTUNITIES FOR DEVELOPMENT OF USDA PROGRAMS

This Chapter presents the opportunities available for solving identified problems and for meeting anticipated needs through the application of programs administered by the United States Department of Agriculture. The individual landowners initiative is required for obtaining USDA assistance for individual practices such as land treatment. Other measures such as flood control, municipal and industrial water supply, recreational structures, environmental corridors, and certain types of land treatment require group or community action. Landowners need to be informed of the assistance available from USDA service agencies so action programs may be selected.

The Resource Conservation and Development Program could be organized locally to sponsor RC&D projects. These projects would be designed to carry out the program of land conservation and utilization, accelerated economic development, reduction of chronic unemployment, and underemployment in areas where these activities are needed to foster a sound local economy.

The Lamine River Watershed lacks economic feasibility for an early action project. All other watersheds studied and discussed in this chapter are economically feasible under present criteria and are classified as early action projects.

LAND TREATMENT AND LAND USE MEASURES

Land treatment measures can be installed with technical assistance provided through local Soil and Water Conservation Districts. These districts established under state law as political units, support and encourage erosion control through proper land use and a system of conservation treatment practices. The Soil Conservation Service provides technical assistance under PL-46 to plan and apply land treatment measures through Soil and Water Conservation Districts. Presently, only Morgan County is not organized as a Soil and Water Conservation District to receive such assistance.

In a watershed authorized for construction under the PL-566 program, additional money is available to accelerate the technical assistance of land treatment measures to protect the works of improvement to be installed. Also certain gully control structures can be installed as a part of a land treatment program with technical assistance and cost sharing from PL-566 funds. The Agricultural Stabilization and Conservation Service cost-shares in applying most needed land treatment measures.

FOREST DEVELOPMENT

Assistance in forest management to apply treatment needs can be fully implemented under existing cooperative forestry programs. These needs may be eligible for assistance from local, state or other federal agency programs.

1. Reforestation

Three different planting programs have been recommended in the plan discussed. Two of these, the cottonwood and conifer plantings, have been recommended primarily for the environmental quality objective and hydrologic stand improvement. In contrast, the walnut plantings were recommended for an

economic objective.

The Forestry Incentive Program, administered jointly by the Agricultural Stabilization and Conservation Service and Forest Service, can provide federal subsidies up to 75 percent to private landowners for establishment of stands of trees for forestry purposes or environmental improvement and can provide technical assistance.

Title IV of the Agricultural Act of 1956 provides assistance to states for tree planting and reforestation to help assure an adequate future supply of industrial wood. Technical assistance may be provided at no cost to the landowner, and federal-state cost sharing, including contractual services, is also available on private land. The landowner's cost for this assistance would be approximately 25 percent. The Forest Service is lead agency under this program.

Section 4 of the Clarke-McNary Act of 1924 provides for the production, purchase and distribution of planting stock or seed for forest, wind barrier or watershed plantings so that private landowners may acquire planting stock at moderate prices. State Forestry agencies generally administer this program in cooperation with the Forest Service. The Watershed Protection and Flood Prevention Act of 1954 (PL-566), as amended, can also provide an avenue for establishment of the recommended plantings.

2. Timber Stand Improvement

The Forestry Incentives Program provides financial assistance for such cultural practices as planting, pruning, thinning, release cuttings and erosion control as well as the technical assistance required to implement these measures.

The General Forestry Assistance Program (GFA), under the authority of the Annual Appropriation Act and the Cooperative Forest Management Act of 1950 as amended, provides for federally funded technical assistance to private landowners for improvement of existing forest lands. Neither of these regulations, however, provide implementation monies. The Watershed Protection and Flood Prevention Act of 1954 (PL-566), provides for technical assistance funds to accelerate timber stand improvements as well as other management practices on small watershed lands.

3. Grazing Control

Grazing control of forest land consists of fencing the area so domestic livestock cannot destroy the advanced reproduction and watershed protection capabilities of the forest land. On-going forestry programs are designed to restrict grazing on forest land. The Agriculture Stabilization and Conservation Service (ASCS), Agriculture Conservation Program (ACP) provides cost-sharing for fencing to the landowner at a 75-25 percent-ratio.

WATER SUPPLY AND WATER QUALITY

The Farmers Home Administration can assist communities of 10,000 or less in obtaining water and sewage systems. To be eligible, the community must be located in an area for which a regional water and sewer plan has been

developed. In general, water supply and distribution systems are feasible with FmHA assistance when population concentrations can provide four or more service connections per mile of service main. Assistance from the FmHA is in the form of grants and loans for planning and construction and through purchase of revenue bonds that cannot be sold on the open market.

The need for municipal water is being met by multiple water storage in the three Alternative Plans. The loan facilities of FmHA would be available for a PL-566 multiple purpose reservoir with water storage for Sedalia, Higginsville and Sweet Springs.

FISH AND WILDLIFE

The Watershed Protection and Flood Prevention Act (PL-566) offers opportunities to include water related fish and wildlife purposes. A watershed with a drainage area of less than 75,000 acres is eligible for including one development for fish and wildlife purposes, two developments are eligible for project with a drainage area between 75,000 and 150,000 acres or three developments for a project of more than 150,000 acres. A water resource improvement for fish and wildlife purposes may include: storage capacity for fish and wildlife use in the reservoir or for use downstream from the reservoir; control of the lake level; stream channel alteration; fill and level ditches, pits, or ponds; and marsh development. Federal cost-sharing is up to 50 percent for land rights, structural measures and needed basic facilities.

Technical assistance program of the Soil Conservation Service (PL-46) provides technical help for most aspects of needed land treatment including application of fish and wildlife measures. Assistance can be provided on areas primarily used for fish and wildlife or as a secondary land use integrated with another primary land use.

The Agriculture Conservation Program offers cost sharing incentives of up to 80 percent of the total cost for restoration or creation of wildlife habitat.

RECREATION

Opportunities to supplement the income of basin residents are associated with providing recreation lands and facilities to serve people from outside the basin. The Small Watershed Program under provisions of Public Law 566 offers this opportunity for public recreation developments. Fifty percent cost-sharing is available on construction and land acquisition for recreation. Loans from the Farmers Home Administration are available to develop income-producing recreation facilities. Assistance is also available to communities and enterprises through the Federal Extension Service to exploit the opportunities for outdoor and on-farm recreation.

POTENTIAL WATER PROJECTS

Many of the preceding programs are complemented or incorporated in Public Law 566, Small Watershed Program. This program is designed to coordinate all USDA Conservation Programs within approved project areas and to assist communities in accomplishing more complete water management. Application for this type assistance is limited to drainage areas of 250,000 acres

or less and encourages community action in the functions of flood protection and prevention, soil conservation, recreation, fish and wildlife, water supply, and to a limited degree -- drainage and irrigation. Multiple applications to be planned concurrently may be submitted if the goal is to achieve flood prevention along a mainstem. For instance, separate applications on South Fork Blackwater, North Fork Blackwater, Post Oak and Clear Creek with adjoining tributaries could be developed concurrently to provide protection of the Blackwater River in Johnson County. The applications must be submitted by Soil and Water Conservation Districts, watershed subdistricts or other legal entities of state government.

Opportunities for development through the Public Law 566 Program fall into two major categories -- land treatment and structural measures. Additional funds are available for providing technical assistance for installing soil and water conservation land treatment measures on individually owned property. Cost sharing for installing these measures may be available, as a necessary incentive to meet the project objectives. Funds for technical assistance and grants are available also for installing structural measures to supplement the land treatment program. One multiple purpose structure in Plans A and C on Clear Creek in the Upper Blackwater River Watershed has storage in excess of 25,000 acre feet. This structure, if selected, would have to be installed under authorities other than PL-566. Structures proposed in Alternative Plan B meet the criteria of PL-566.

All watersheds except the Lamine River Watershed have opportunities for potential projects in the early-action program (Map 25). Total floodwater damages amount to $4,488,060 projected to the year 2000 using current normal prices from the February 1974, "Agricultural Price Standards for Water and Related Land Resources Planning" (Table 102). The beneficial and adverse effects by watersheds are displayed in this Chapter along with a short description of each watershed (Tables 103 through 115).

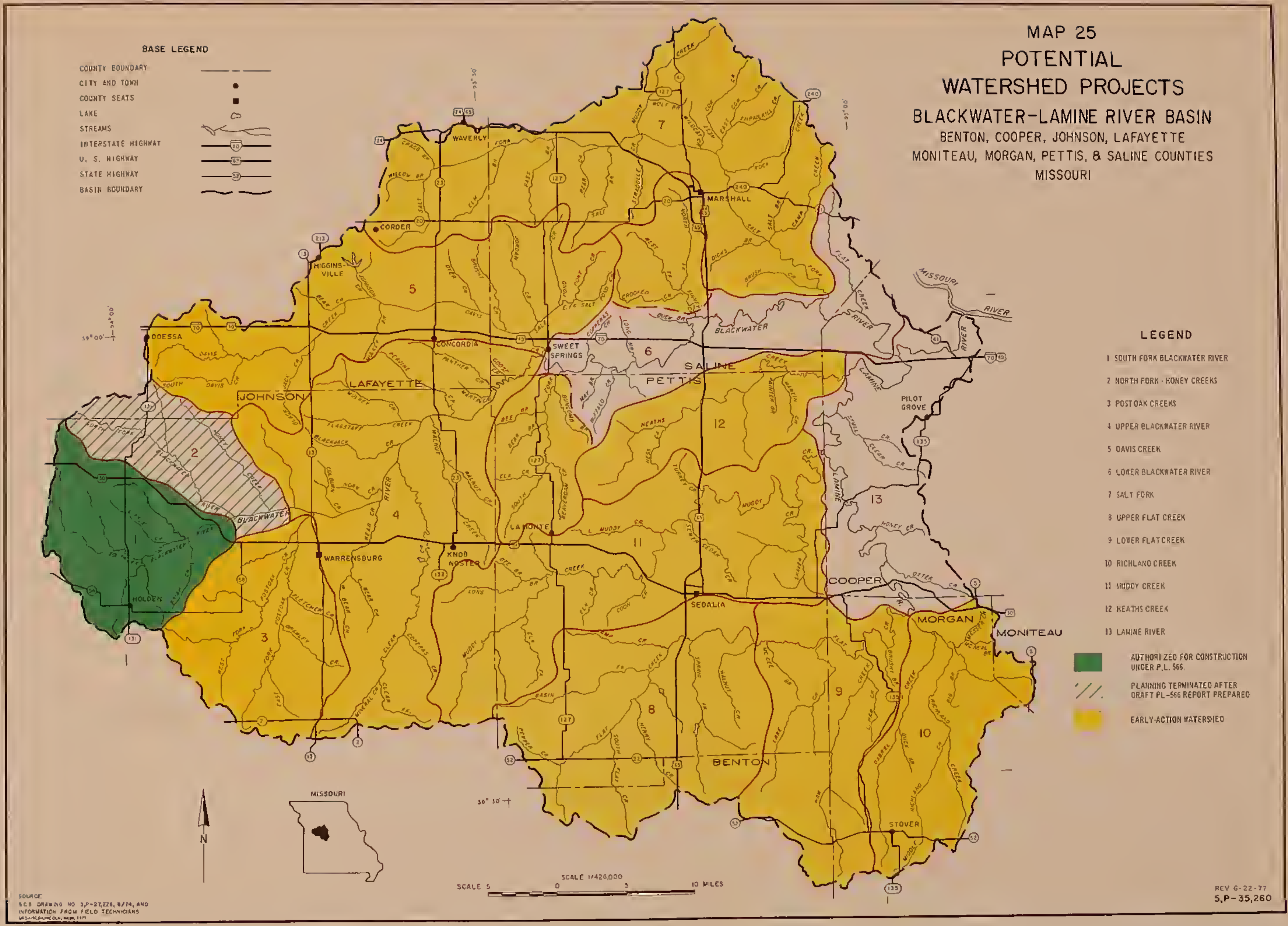

MAP 25
POTENTIAL
WATERSHED PROJECTS
BLACKWATER-LAMINE RIVER BASIN
BENTON, COOPER, JOHNSON, LAFAYETTE
MONITEAU, MORGAN, PETTIS, & SALINE COUNTIES
MISSOURI
BASE LEGEND
COUNTY BOUNDARY
CITY AND TOWN
COUNTY SEATS
LAKE
STREAMS
INTERSTATE HIGHWAY
U. S. HIGHWAY
STATE HIGHWAY
BASIN BOUNDARY
LEGEND
1 SOUTH FORK BLACKWATER RIVER
2 NORTH FORK - HONEY CREEKS
3 POSTOAK CREEKS
4 UPPER BLACKWATER RIVER
5 DAVIS CREEK
6 LOWER BLACKWATER RIVER
7 SALT FORK
8 UPPER FLAT CREEK
9 LOWER FLAT CREEK
10 RICHLAND CREEK
11 MUDDY CREEK
12 HEATHS CREEK
13 LAMINE RIVER
AUTHORIZED FOR CONSTRUCTION UNDER P.L. 566.
PLANNING TERMINATED AFTER DRAFT PL-566 REPORT PREPARED
EARLY-ACTION WATERSHED
LAFAYETTE
JOHNSON
SALINE
PETTIS
COOPER
MORGAN
MONITEAU
BENTON
MARSHALL
SEDALIA
WARRENSBURG
CONCORDIA
SWEET SPRINGS
HIGGINSVILLE
ODESSA
CORDER
WAVERLY
KNOB NOSTER
LA MONTE
HOLDEN
PILOT GROVE
STOVER
MISSOURI RIVER
BLACKWATER
MISSOURI
N
SCALE 1/426,000
SCALE 5 0 5 10 MILES
SOURCE:
SCS DRAWING NO 5,P-27,226, 8/74, AND INFORMATION FROM FIELD TECHNICIANS
REV 6-22-77
5,P-35,260

Table 102.--Floodwater Damages by Watersheds for Year 2000, Blackwater-Lamine River Basin, Missouri

Watershed -map no-	----name----	Flood plain Total	Flood plain Average annual	Crop and pasture	Other Agricul.	Roads, bridges	Sediment	Scour	Swamping	Stream-bank erosion	Sub total	Indirect	TOTAL damage
		-----acres-----		- - -	- - -	- -	- - -	- - dollars	- -	- -	- - -	- -	- - -
BLACKWATER SUBBASIN													
3	Post Oak Creeks	6,830	5,830	222,370	22,240	21,110	70	5,400	650		271,840	27,180	299,020
4	Upper Blackwater River	21,130	26,410	719,730	71,970	47,160	460	65,460	5,640	6,440	916,860	91,690	1,008,550
5	Davis Creek	13,320	8,100	259,500	25,950	22,500	25,120	22,870	5,510	5,610	367,060	36,700	403,760
6	Lower Blackwater River	11,810	7,920	240,300	24,030	17,010	9,930				291,270	29,130	320,400
7	Salt Fork	13,150	10,240	370,890	37,090	40,520	16,710	1,260			466,470	46,650	513,120
	TOTAL	66,240	58,500	1,812,790	181,280	148,300	52,290	94,990	11,800	12,050	2,313,500	231,350	2,544,850
LAMINE SUBBASIN													
8	Upper Flat Creek	6,770	5,950	122,010	12,200	18,150	13,680	45,760	17,290		229,090	22,910	252,000
9	Lower Flat Creek	8,660	6,700	203,630	20,360	14,700	9,410	38,480	23,290		309,870	30,990	340,860
10	Richland Creek	4,140	1,620	46,430	4,640	1,890	8,870	15,090			76,920	7,700	84,620
11	Muddy Creek	12,710	13,050	308,980	30,900	34,730	26,290	102,230			503,130	50,310	553,440
12	Heaths Creek	3,110	2,620	79,660	7,970	6,220	1,600	12,930	1,030		109,410	10,940	120,350
13	Lamine River	11,740	8,500	352,740	35,280	19.690	8,100	122,310			538,120	53,810	591,930
	TOTAL	47,130	38,440	1,113,450	111,350	95,380	67,950	336,800	41,610		1,766,540	176,660	1,943,200
TOTAL BASIN		113,370	96,940	2,926,240	292,630	243,680	120,240	431,790	53,410	12,050	4,080,040	408,020	4,488,060

Price Base: Current Normal Prices, WRC, February, 1974.

Table 103.--Blackwater River Subbasin, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans A		B		C	
	-no-	-dollars-	-no-	-dollars-	-no-	-dollars-
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		697,790		844,000		541,710
More intensive land use		177,520		243,720		129,330
Changed land use		188,750		326,800		146,430
Levee system				228,880		
Subtotal		1,064,060		1,643,400		817,470
Downstream						
Floodwater damage reduction		109,530		116,450		51,470
More intensive land use		18,420		24,440		8,100
Changed land use		32,500		41,830		15,730
Subtotal		160,450		182,720		75,300
Total flood prevention		1,224,510		1,826,120		892,770
M&I water supply		48,960		48,960		48,960
Recreation		2,182,900		709,250		2,443,900
Gully stabilization control						272,350
Streambank erosion control						13,250
Drainage				74,070		
Utilization unemployment		125,800		114,360		163,330
Environmental corridor						68,250
Total beneficial effects		3,582,170		2,772,760		3,902,810
Adverse effects 2/						
Flood prevention structure						
Project installation	5	121,250	46	725,920		
OM&R		5,070		33,270		
Multiple MI and FP structure						
Project installation	2	46,770	2	46,770	2	46,770
OM&R		2,190		2,190		2,190
Multiple Rec & FP structure						
Project installation	10	1,344,370	5	518,790	11	1,499,190
OM&R		749,110		249,280		838,170
Gully stabilization structure						
Project installation					63	278,460
OM&R						13,970
Streambank control structure						
Project installation					9	129,690
OM&R						7,920
Levee and drainage						
Project installation				220,900		
OM&R				143,620		
Environmental corridor						82,250
Project Administration		176,420		194,160		248,230
Total adverse effects		2,445,180		2,134,900		3,146,840
Net benefits		1,136,990		637,860		755,970
Benefit cost ratio		1.46:1		1.30:1		1.24:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974.
2/ Amortized for 100 years @ 5 5/8 percent interest.

1. South Fork Blackwater Watershed

A watershed application for the South Fork Blackwater Watershed was approved for assistance under the authority of Public Law 566. A watershed plan was completed in 1962, and a revised plan was completed in 1974.

The watershed has a drainage area of 102.46 square miles and is located in Johnson County. Downstream effects were evaluated on all Alternative Plans using a project formulation controlling 46.11 square miles of the watershed. Floodwater reduction benefits along the mainstem of Blackwater River allocated to the South Fork Blackwater Watershed was $83,270 for Plan A; $81,540 for Plan B; and $69,430 for Plan C. No studies of floodwater damages and benefits were conducted within the watershed for this basin plan.

2. North Fork - Honey Creeks Watershed

North Fork-Honey Creek Watershed was authorized for planning under authority of Public Law 566 in December, 1967. The watershed has a drainage area of 97.15 square miles and is located in Johnson and Lafayette Counties. Planning is inactive at the present time.

For the purpose of determining downstream effects, a project formulation controlling 48.91 square miles of the watershed was evaluated for all alternative plans. Floodwater damage reduction benefits allocated to this watershed was $87,740 for Plan A; $88,390 for Plan B; and $73,110 for Plan C. No studies of floodwater damages and benefits were conducted within the watershed for this basin plan.

3. Post Oak Creek Watershed

Post Oak Creek Watershed is located in the southwestern part of the basin. The watershed is located in the Johnson County Soil and Water Conservation District. It has a drainage area of 135.52 square miles. Post Oak Creek is one of three headwater tributaries forming the Blackwater River. The city of Warrensburg lies on the border of Post Oak and Upper Blackwater Watershed. It had a population of 13,125 in 1970 and is the fastest growing city in the basin, doubling in population from 1960 to 1970. Central Missouri State University is located in Warrensburg with an enrollment of over 10,000 students. U.S. Highway 50 traverses the watershed connecting Warrensburg with Kansas City and Jefferson City, Missouri.

The major problems are flooding, flood plain scour, gully erosion and the lack of adequate water-based recreation. Two major tributaries, East Fork and West Fork join about three miles above the confluence with Blackwater River. The flood plain contains 6,830 acres or about eight percent of the watershed. Flooding of cropland and pastureland is severe with 5,830 acres or 85 percent of the flood plain flooding annually. Projected estimated floodwater damages amount to $299,020 annually.

Alternative Plan A proposes 3 single purpose flood prevention structures and one multiple purpose flood prevention and recreation structure. The structures control 71.03 square miles or 52.4 percent of the drainage resulting in $337,010 flood prevention benefits. Two-thirds or $219,780 of the flood reduction benefits originate from within the watershed and $117,230

downstream from the watershed. The multiple purpose structure, a lake with a surface area of 200 acres, can provide 73,600 recreation visits and $110,400 recreation benefits. Eighty-five percent of this use originates from outside the basin. Construction of this plan would provide $11,110 in benefits toward the utilization of unemployed labor. Total annual beneficial effects are $458,520 and adverse effects $205,640 resulting in net benefits of $252,880 (Table 104).

Alternative Plan B proposes 11 single purpose flood prevention structures controlling 72.84 square miles or 54.5 percent of the area. Total flood prevention benefits amount to $352,800 of which $230,990 are within the watershed and $121,810 from outside the watershed. Unemployment benefits amount to $10,610. Total annual beneficial effects are $363,410 and adverse effects $190,100 resulting in net benefits of $173,310.

Alternative Plan C proposes one multiple purpose flood prevention and recreation structure controlling 26.65 square miles or 19.7 percent of the watershed. Flood prevention benefits are reduced to $126,850 of which $90,520 are from within the watershed and $36,330 originate downstream. Plan C places emphasis on the upland grade stabilization problem with 16 gully stabilization structures. Recreation would provide the same number of recreation visits and benefits as Plan A. Benefits for the utilization of the unemployed amount to $12,060. Total annual beneficial effects are $318,480 and adverse effects $214,140 resulting in net benefits of $104,340.

Table 104.--Post Oak Creek Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		162,260		159,710		67,400
More intensive land use		34,330		34,590		14,120
Changed land use		23,190		36,690		9,000
Subtotal		219,780		230,990		90,520
Downstream						
Flood damage reduction		85,890		87,650		29,630
More intensive land use		12,040		13,300		2,810
Changed land use		19,300		20,860		3,890
Subtotal		117,230		121,810		36,330
Total flood prevention		337,010		352,800		126,850
Recreation		110,400				110,400
Gully stabilization control						69,170
Utilization unemployment		11,110		10,610		12,060
Total beneficial effects		458,520		363,410		318,480
Adverse effects 2/						
Flood prevention structure						
Project installation	3	65,510	11	160,080		
OM&R		2,870		7,510		
Multiple Rec and FP structure						
Project installation	1	79,120			1	79,120
OM&R		39,700				39,700
Gully stabilization structure						
Project installation					16	70,720
OM&R						3,550
Project administration		18,440		22,510		21,050
Total adverse effects		205,640		190,100		214,140
Net benefits		252,880		173,310		104,340
Benefit cost ratio		2.23:1		1.91:1		1.49:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

4. Upper Blackwater River Watershed

The Upper Blackwater River Watershed contains 329.22 square miles. The Upper Blackwater River is formed by three major headwater tributaries with a combined drainage area of 355.04 square miles. The lower end of the watershed has 684.26 square miles of drainage area at its confluence of Davis Creek. The watershed is located in Johnson, Lafayette, Saline and Pettis Counties. The watershed lies within Soil and Water Conservation District boundaries of these four counties.

The watershed has severe problems of flooding, flood plain scour, deposition, swamping and channel bank erosion. Its bottom land is 21,130 acres. Some reaches have three to four floods per year resulting in 26,410 acres flooding annually. Road and bridge damages have resulted in some roads and bridges being abandoned. Total floodwater damages amount to $1,008,550 annually. There is a need for control of sheet and gully erosion.

Plan A proposes four multiple purpose structures controlling 107.23 square miles of the watershed. Out of a total of $313,850 flood reduction benefits $289,180 accrue to works of improvement within the watershed and $24,670 from downstream benefits. Flood reduction benefits from the mainstem reach of this watershed have been allocated to the three watersheds upstream.

The four multiple purpose structures create 1,850 acres of surface water for recreation providing 665,400 recreation visits and $998,100 recreation benefits. Eighteen percent of the recreation benefits originate from within the basin and 82 percent from outside the basin. One multiple purpose structure on Clear Creek has a drainage area of 67.45 square miles. Its dam site is located within the Knob Noster State Park. This structure, as proposed exceeds the total storage capacity allowed under PL-566.

Unemployment benefits amount to $43,080. Total annual beneficial effects are $1,355,030 and adverse effects $935,040 resulting in net benefits of $419,990 (Table 105).

Alternative Plan B proposes about the same square miles of control as Plan A, 107.10 square miles but with 12 single purpose flood prevention sites and 2 multiple purpose flood prevention and recreation structures. In addition to the floodwater retarding structures; 13.1 miles of levees, a pumping plant, and a drainage system is proposed to directly benefit 3,243 acres of flood plain lands. Total flood reduction benefits amount to $633,480 annually. Within the watershed, flood retarding structures are accredited with $377,090 flood prevention benefits and the levee system $228,880. Downstream flood prevention benefits are $27,510. The levee system together with pumping plants and field laterals result in $74,070 of drainage benefits.

The two multiple purpose recreation structures provide 450 surface acres of water and 164,600 recreation visits. Recreation benefits from these structures amount to $246,900. The utilization of unemployed labor results in benefits of $40,200. Total annual beneficial effects total $994,650 and adverse effects $901,580 resulting in net benefits of $93,070.

Alternative Plan C proposes the same multiple purpose structures as Plan A. Total flood prevention benefits are $305,020. Benefits within the

watershed amount to $280,820 and downstream $24,200. Recreation benefits of $998,100 are same as Alternative Plan A.

Alternative Plan C places emphasis on a high degree of erosion control. Three streambank control structures to combat a loss of 8.4 acres of flood plain lands annually and 23 gully stabilization structures are proposed. Benefits from these erosion control measures amount to $106,510. Utilization of unemployment provides benefits of $54,010.

A 17 mile reach of Clear Creek has an above average rating for an environmental corridor. The gross area of 13,500 acres encompasses a multiple purpose structure with an area of 4,400 acres leaving a net corridor area of 9,100 acres. Benefits from 91,000 recreation visits annually are estimated at $68,250. Total annual beneficial effects amount to $1,531,890 and adverse effects of $1,193,840 resulting in $338,050 of net benefits.

Table 105.--Upper Blackwater River Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		207,140		233,980		200,120
More intensive land use		29,780		48,100		29,660
Changed land use		52,260		95,010		51,040
Levee system				228,880		
Subtotal		289,180		605,970		280,820
Downstream						
Floodwater damage reduction		13,750		13,580		13,850
More intensive land use		3,500		4,770		3,110
Changed land use		7,420		9,160		7,240
Subtotal		24,670		27,510		24,200
Total flood prevention		313,850		633,480		305,020
Drainage				74,070		
Recreation		998,100		246,900		998,100
Gully stabilization control						99,430
Streambank erosion control						7,080
Utilization unemployment		43,080		40,200		54,010
Environmental corridor						68,250
Total beneficial effects		1,355,030		994,650		1,531,890
Adverse effects 2/						
Flood prevention structure						
Project installation			12	181,170		
OM&R				8,790		
Multiple Rec and FP structure						
Project installation	4	544,250	2	186,650	4	544,250
OM&R		335,170		86,890		335,170
Gully stabilization structure						
Project installation					23	101,660
OM&R						5,100
Streambank control structure					3	43,230
OM&R						2,640
Levee and Drainage						
Project installation				220,900		
OM&R				143,620		
Environmental corridor						82,250
Project administration		55,620		73,560		79,540
Total adverse effects		935,040		901,580		1,193,840
Net benefits		419,990		93,070		338,050
Benefit cost ratio		1.45:1		1.10:1		1.28:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest.

5. Davis Creek Watershed

Davis Creek Watershed, 241.34 square miles, is a tributary of the Blackwater River. Davis Creek enters the Blackwater River near the town of Sweet Springs. The watershed is located in Johnson, Lafayette and Saline Counties, which have Soil and Water Conservation Districts. The towns of Concordia, Higginsville, Odessa and Sweet Springs are located along the watershed boundaries.

Flooding is a problem on 13,320 acres of flood plain lands. Total floodwater damages are estimated at $403,750 annually. About 64 percent of the damages are to crops and pastures.

Alternative Plan A proposes 70.12 square miles of control with four structures controlling 29 percent of the watershed. One is a single purpose flood prevention structure. Two structures are multiple purpose with flood storage and municipal water storage for the towns of Higginsville and Sweet Springs. The municipal water storage is adequate to serve projected population of 9,850 for Higginsville and 4,020 for Sweet Springs. Municipal water benefits amount to $48,960 annually. The other multiple purpose structure has flood storage and a 500 acre lake for recreation. The lake plus the recreation facilities has a capacity of 210,000 visits annually. Since Interstate Highway 70 traverses the length of the watershed, 95 percent of the recreation visits are expected to originate from outside the basin. Recreation benefits amount to $315,000 annually.

Flood reduction benefits are $251,510 annually. About 6 percent or $16,220 originates downstream along the mainstem of Lower Blackwater River. Local labor is expected to benefit $26,080 annually from construction of the project. Total beneficial effects amount to $641,550 and adverse effects $430,980 resulting in net benefits of $210,570 (Table 106).

Alternative Plan B proposes 107.37 square miles of control or 44 percent of the watershed with 12 single purpose flood prevention structures and two multiple purpose structures. The two multiple purpose structures have flood storage and water supply and are the same sites proposed in Plan A. Flood reduction benefits total $406,660 annually of which $378,740 originates within the watershed and $27,920 from downstream on the Lower Blackwater River. Total annual beneficial effects are $474,300 and adverse effects $281,100 resulting in net benefits of $193,200.

Alternative Plan C proposes the three multiple purpose structures in Alternative Plan A. Drainage area controlled is 55.28 square miles or 23 percent of the watershed. Flood prevention benefits amount to $184,630 of which $12,190 comes from outside the watershed.

Recreation and municipal water benefits are the same as Plan A. This plan proposes 24 gully control structures and six streambank control structures for a benefit of $109,920. Total beneficial effects amount to $698,050 annually and adverse effects of $637,270 resulting in net benefits of $60,780.

Table 106.--Davis Creek Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		113,020		179,470		86,450
More intensive land use		72,890		104,180		51,530
Changed land use		49,380		95,090		34,460
Subtotal		235,290		378,740		172,440
Downstream						
Floodwater damage reduction		9,040		13,770		6,980
More intensive land use		2,300		4,840		1,560
Changed land use		4,880		9,310		3,650
Subtotal		16,220		27,920		12,190
Total flood prevention		251,510		406,660		184,630
M&I water supply		48,960		48,960		48,960
Recreation		315,000				315,000
Gully stabilization						103,750
Streambank control						6,170
Utilization unemployment		26,080		18,680		39,540
Total beneficial effects		641,550		474,300		698,050
Adverse effects 2/						
Flood prevention structure						
Project installation	1	25,090	12	190,220		
OM&R		1,070		8,850		
Multiple MI and FP structure						
Project installation	2	46,770	2	46,770	2	46,770
OM&R		2,190		2,190		2,190
Multiple Rec and FP structure						
Project installation	1	221,330			1	221,330
OM&R		96,340				96,340
Gully stabilization structure						
Project installation					24	106,080
OM&R						5,320
Streambank control structure						
Project installation					6	86,460
OM&R						5,280
Project administration		38,190		33,070		67,500
Total adverse effects		430,980		281,100		637,270
Net benefits		210,570		193,200		60,780
Benefit cost ratio		1.49:1		1.69:1		1.10:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

6. Lower Blackwater River Watershed

The Lower Blackwater River Watershed includes the segment from the junction of Davis Creek to the confluence of the Blackwater River and the Lamine River. The watershed contains 270.02 square miles. The upper end of the watershed has 925.60 square miles and the lower end 1549.33 square miles of drainage area. One major tributary watershed, Salt Fork, with a drainage area of 353.71 square miles enters near the outlet of the Blackwater River. Lower Blackwater River Watershed is located in Pettis, Saline and Cooper Counties all having organized Soil and Water Conservation Districts.

The flood plain is narrow for the size of the drainage area, 870 to 2,700 feet. The total flood plain is 11,810 acres with an average of 7,920 acres flooding annually. Total flood water damages are $320,400 annually with 75 percent of this damage to crops and pastures. The remaining damages are to fences, roads, and bridges.

Alternative Plan A proposes two multiple purpose structures with storage for flood control and recreation. The drainage area of these two structures is 52.40 square miles. Flood prevention benefits within the watershed are $67,290. An additional $81,590 of floodwater reduction benefits was allocated from Lower Blackwater River mainstem to the upstream watersheds.

The two recreation lakes would provide 550 surface acres of water and a total of 199,950 recreation visits per year. Total recreation benefits are $299,900 of which 72 percent originates from outside the basin. Benefits for the utilization of unemployed local labor are $16,460.

Total beneficial effects are $383,650 and adverse effects are $312,690 resulting in net benefits of $70,960 (Table 107).

Alternative Plan B proposes 3 single purpose floodwater retarding structures and one multiple purpose floodwater and recreation structure. The drainage area of the four structures is 51.39 square miles. Flood reduction benefits amount to $95,800.

The share of the floodwater reduction benefits in the Lower Blackwater Watershed allocated to upstream watersheds is $103,950.

The multiple purpose structure provides 200 acres for recreation. The lake and recreation facilities have a capacity of 73,600 recreation visits annually and benefits of $110,400. Seventy-two percent of the benefits originate from outside the basin. Benefits for the utilization of unemployed labor are $10,610 annually. Total beneficial effects are $216,810 and adverse effects of $199,000 resulting in net benefits of $17,810.

Alternative Plan C within the Lower Blackwater River Watershed has the same project formulation as Alternative Plan A. Total beneficial effects are $383,410 and adverse effects are $312,690 resulting in net benefits of $70,720. Variation of benefits between these two plans resulted from allocation of benefits to the Lower Blackwater from the entire subbasin. An additional $66,410 flood reduction benefits from the Lower Blackwater River mainstem are allocated to upstream watersheds.

Table 107.--Lower Blackwater River Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		36,950		43,180		37,000
More intensive land use		9,110		16,230		8,910
Changed land use		21,230		36,390		21,140
Total flood prevention		67,290		95,800		67,050
Recreation		299,900		110,400		299,900
Utilization unemployment		16,460		10,610		16,460
Total beneficial effects		383,650		216,810		383,410
Adverse effects 2/						
Flood prevention structures						
Project installation			3	64,140		
OM&R				2,800		
Multiple Rec and FP structure						
Project installation	2	186,410	1	75,240	2	186,410
OM&R		104,270		39,420		104,270
Project administration		22,010		17,400		22,010
Total adverse effects		312,690		199,000		312,690
Net benefits		70,960		17,810		70,720
Benefit cost ratio		1.23:1		1.09:1		1.23:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

7. Salt Fork Watershed

Salt Fork is a major tributary of the Blackwater River with a drainage area of 353.71 square miles. The watershed is located in Lafayette and Saline Counties both having organized Soil and Water Conservation Districts.

The watershed has 13,150 acres of flood plain with 10,240 acres being flooded on an average annual basis. Total damages amounted to $513,120 with $370,890 of this total from crops and pasture.

Alternative Plan A proposes one single purpose flood prevention structure and two multiple purpose flood prevention and recreation structures controlling 69.65 square miles. Total flood prevention benefits are $254,850 of which $252,520 is from within the watershed and $2,330 originates downstream on the Blackwater River (Table 108).

The two recreation structures provides 850 acres of surface water. The lakes, along with recreation facilities, have a capacity of 306,350 recreation visits a year. Recreation benefits are $459,500 of which $327,050 originates from outside the basin. Benefits from the utilization of unemployment amount to $29,070. Total beneficial effects are $743,420 and adverse effects $560,830 resulting in net benefits of $182,590.

Alternative Plan B proposes 8 single purpose flood prevention structures and two recreation structures. Total drainage area controlled is 108.84 or 30.8 percent of the watershed. Total floodwater prevention benefits amount to $337,380. Benefits within the watershed are $331,900 and $5,480 from outside the watershed.

The two recreation structures in Plan B have 650 acres of surface water providing 234,650 recreation visits. The recreation benefits amount to $351,950 of which $249,610 comes from outside the basin. Benefits from the utilization of unemployment is $34,260. Total annual beneficial effects amount to $723,590 and adverse effects $563,120 resulting in net benefits of $160,470.

Alternative Plan C proposes three multiple purpose flood prevention and recreation structures controlling 76.18 square miles. Floodwater prevention benefits amount to $209,220. Benefits within the watershed are $206,640 and $2,580 from downstream on the Blackwater River.

The three recreation lakes have 1,250 acres of surface water. Total recreation visits expected are 450,350 yielding $720,500 in recreation benefits. The recreation benefits coming from outside the basin amount to $514,970. Unemployment benefits amount to $41,260. Total beneficial effects amount to $970,980 and adverse effects $788,900 resulting in net benefits of $182,080.

Table 108.--Salt Fork Creek Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		178,420		227,660		150,740
More intensive land use		31,410		40,620		25,110
Changed land use		42,690		63,620		30,790
Subtotal		252,520		331,900		206,640
Downstream						
Floodwater damage reduction		850		1,450		1,010
More intensive land use		580		1,530		620
Changed land use		900		2,500		950
Subtotal		2,330		5,480		2,580
Total flood prevention		254,850		337,380		209,220
Recreation		459,500		351,950		720,500
Utilization unemployment		29,070		34,260		41,260
Total beneficial effects		743,420		723,590		970,980
Adverse effects 2/						
Flood prevention structure						
Project installation	1	30,650	8	130,310		
OM&R		1,130		5,320		
Multiple Rec and FP structure						
Project installation	2	313,260	2	256,900	3	468,080
OM&R		173,630		122,970		262,690
Project administration		42,160		47,620		58,130
Total adverse effects		560,830		563,120		788,900
Net benefits		182,590		160,470		182,080
Benefit cost ratio		1.33:1.0		1.28:1.0		1.23:1.0

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest.

Table 109.--Lamine River Subbasin, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		720,510		809,170		326,750
More invensive land use		117,210		145,180		36,880
Changed land use		335,810		425,120		81,580
Subtotal		1,173,530		1,379,470		445,210
Downstream						
Floodwater damage reduction		476,550		472,400		233,100
More intensive land use		35,290		36,810		3,720
Changed land use		52,030		56,900		5,720
Subtotal		563,870		566,110		242,540
Total flood prevention		1,737,400		1,945,580		687,750
M&I water supply		80,190		80,190		80,190
Recreation		1,275,650		630,010		1,171,550
Environmental corridors						119,300
Utilization unemployment		115,980		108,020		95,570
Total beneficial effects		3,209,220		2,763,800		2,154,360
Adverse effects 2/						
Flood prevention structure						
Project installation	9	279,780	43	788,050		
OM&R		13,580		37,930		
Multiple MI and FP structure						
Project installation	1	76,730	1	76,730	1	76,730
OM&R		3,460		3,460		3,460
Multiple Rec and FP structure						
Project installation	8	956,430	5	518,760	8	953,830
OM&R		455,950		229,700		425,470
Environmental corridors						143,930
Project administration		189,640		200,050		150,460
Total adverse effects		1,975,570		1,854,680		1,753,880
Net benefits		1,233,650		909,120		400,480
Benefit cost ratio		1.62:1		1.49:1		1.23:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

8. Upper Flat Creek Watershed

Flat Creek is a headwater tributary of the Lamine River. Flat Creek is divided into upper and lower watersheds. The Upper Flat Creek Watershed has a 226.91 square mile drainage area. The watershed is located in Pettis, Benton, and Johnson Counties which have organized Soil and Water Conservation Districts.

Flooding is a serious problem along with sediment, scour, and swamping damages on the flood plain. On the 6,770 acre flood plain, an average of 5,950 acres are flooded annually. Annual floodwater damages are $252,000.

Alternative Plan A proposes 7 structures controlling 132.42 square miles or 58.4 percent. Five of the structures are single purpose flood prevention. One structure is a multi-purpose flood prevention with municipal water storage for the city of Sedalia. The municipal water storage is expected to serve Sedalia with a projected population of 60,870 to year 2020. The other multi-purpose structure provides flood storage and a 200 acre lake for recreation. The lake and recreation facilities are expected to serve 73,600 visitor days with an annual benefit of $110,400 (Table 110). Seventy-two percent of the recreation benefits are expected from outside the basin.

Flood prevention benefits are $631,690 of which $308,320 comes from within the watershed and $323,370 from downstream. Total annual beneficial effects are $845,540 and total adverse effects are $411,010 leaving net benefits of $434,530.

Alternative Plan B proposes 11 single purpose flood prevention structures and one multiple purpose flood prevention and municipal water storage structure to serve Sedalia. The structures have a combined drainage area of 129.16 square miles or 56.9 percent of the watershed controlled. Total flood prevention benefits amount to $601,240 of which $259,910 are from within the watershed and $341,330 from downstream. Total annual beneficial effects are $700,120 and adverse effects $336,060 resulting in net benefits of $364,060.

Alternative Plan C proposes two multiple purpose structures, the same multiple purpose structures as Alternative Plan A. These two structures have a drainage area of 41.20 square miles. Floodwater prevention benefits amount to $158,570 of which $36,300 originates from within Upper Flat Creek Watershed and $122,270 from downstream areas. Benefits from water supply and recreation are the same as benefits in Alternative Plan A. Total annual beneficial effects amount to $362,950 and adverse effects $242,180 resulting in net benefits of $120,770.

Table 110.--Upper Flat Creek Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		186,320		160,890		29,590
More intensive land use		23,180		17,740		1,900
Changed land use		98,820		81,280		4,810
Subtotal		308,320		259,910		36,300
Downstream						
Floodwater damage reduction		254,810		264,890		112,830
More intensive land use		23,630		26,410		3,720
Changed land use		44,930		50,030		5,720
Subtotal		323,370		341,330		122,270
Total flood prevention		631,690		601,240		158,570
M&I water supply		80,190		80,190		80,190
Recreation		110,400				110,400
Utilization unemployment		23,260		18,690		13,790
Total beneficial effects		845,540		700,120		362,950
Adverse effects 2/						
Flood prevention structure						
Project installation	5	142,260	11	206,800		
OM&R		6,710		9,780		
Multiple MI and FP structure						
Project installation	1	76,730	1	76,730	1	76,730
OM&R		3,460		3,460		3,460
Multiple Rec and FP structure						
Project installation	1	97,080			1	97,080
OM&R		41,020				41,020
Project administration		43,750		39,290		23,890
Total adverse effects		411,010		336,060		242,180
Net benefits		434,530		364,060		120,770
Benefit cost ratio		2.06:1		2.08:1		1.50:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

9. Lower Flat Creek Watershed

The Lower Flat Creek Watershed is located in Benton, Morgan, and Pettis Counties. All have organized Soil and Water Conservation Districts except Morgan County.

The watershed comprises 173.46 square miles with 226.91 square miles of drainage area at the upper end and 400.37 square miles at the lower end. The watershed has 8,660 acres of flood plain with 6,700 acres flooded annually. Total floodwater damages are $340,860.

Alternative Plan A proposes two multiple purpose flood prevention and recreation structures with a combined drainage area of 79.73 square miles. The recreation lakes provide 600 acres of surface water and together with the recreation facilities will provide 216,600 recreation visits. Annual recreation benefits are estimated at $324,900 with 72 percent of these benefits coming from outside the basin (Table 111).

Floodwater prevention benefits are $274,210 of which $169,150 comes from within the watershed and $105,060 from downstream. Utilization of unemployed labor amounts to $23,380. Total annual beneficial effects amount to $662,490 and adverse effects $390,260 resulting in net benefits of $232,230.

Alternative Plan B proposes eight single purpose floodwater retarding structures controlling 80.75 square miles of drainage area. This plan results in $259,710 of floodwater prevention benefits, $171,750 from within the watershed and $87,960 from downstream. Total annual beneficial effects amount to $270,270 and adverse effects $175,280 resulting in net benefits of $94,990.

Alternative Plan C proposes one multiple purpose flood prevention and recreation structure with 43.45 square miles of drainage area. The 300 acre lake will provide 108,300 recreation visits and $162,450 in recreation benefits. Floodwater prevention benefits amount to $155,640 of which $100,160 comes from within the watershed and $55,480 from downstream. Total annual beneficial effects amount to $329,780 and adverse effects $195,130 resulting in net benefits of $134,650.

Table 111.--Lower Flat Creek Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		117,520		114,860		86,670
More intensive land use		15,860		17,250		5,330
Changed land use		35,770		39,640		8,160
Subtotal		169,150		171,750		100,160
Downstream						
Floodwater damage reduction		96,690		81,200		55,480
More intensive land use		4,590		4,070		
Changed land use		3,780		2,690		
Subtotal		105,060		87,960		55,480
Total flood prevention		274,210		259,710		155,640
Recreation		324,900				162,450
Utilization unemployment		23,380		10,560		11,690
Total beneficial effects		622,490		270,270		329,780
Adverse effects 2/						
Flood prevention structure						
Project installation			8	145,560		
OM&R				7,470		
Multiple Rec and FP structure						
Project installation	2	239,220			1	119,610
OM&R		115,580				57,790
Project administration		35,460		22,250		17,730
Total adverse effects		390,260		175,280		195,130
Net benefits		232,230		94,990		134,650
Benefit cost ratio		1.60:1		1.54:1		1.69:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

10. Richland Creek Watershed

Richland Creek Watershed is located in Morgan County, which does not have an organized Soil and Water Conservation District.

The watershed, having a 137.46 square mile drainage area, has 4140 acres of bottom land with a moderate flooding problem. Average annual acres flooded is 1620 acres. Total floodwater damages are $84,620. About 55 percent of this damage is to crops and pastures and 28 percent from sediment and scour damage.

Alternative Plan A proposes two single purpose flood prevention structures and one multiple purpose flood prevention and recreation structure. The multiple purpose structure provides a 300 acre lake for recreation and facilities to accommodate 108,300 recreation visits. Recreation benefits amount to $162,450 annually (Table 112).

The three structures control 81.33 square miles or 59.2 percent of the watershed. Flood prevention benefits are $244,810 of which $152,540 originate from within the watershed and $92,270 from the mainstem of the Lamine River Watershed. The utilization of unemployed resources amount to $18,750. Total annual beneficial effects are $426,010 and adverse effects $310,080 resulting in net benefits of $115,930.

Alternative Plan B proposes five single purpose flood prevention structures controlling 80.34 square miles. Total floodwater prevention benefits are $265,150. Flood prevention benefits in the watershed amount to $176,400 and $88,750 outside the watershed from the Lamine River mainstem. Utilization of local unemployed resources amount to $8,700. Total annual beneficial effects are $273,850 and adverse effects $147,800 resulting in net benefits of $126,050.

Alternative Plan C proposes one multiple purpose structure with 40.20 square miles of drainage area. This structure provides storage for flood control and recreation. Recreation benefits are the same as Plan A. Total floodwater prevention benefits are $129,170 with $78,400 from within the watershed and $50,770 from the Lamine River mainstem. Benefits from local employment are $14,250. Total beneficial effects are $305,870 and adverse effects $239,190 resulting in net benefits of $66,680.

Table 112.--Richland Creek Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		67,230		73,410		37,250
More intensive land use		17,410		19,580		7,730
Changed land use		57,900		83,410		33,420
Subtotal		152,540		176,400		78,400
Downstream						
Floodwater damage reduction		84,920		81,930		50,770
More intensive land use		4,030		4,110		
Changed land use		3,320		2,710		
Subtotal		92,270		88,750		50,770
Total flood prevention		244,810		265,150		129,170
Recreation		162,450				162,450
Utilization unemployment		18,750		8,700		14,250
Total beneficial effects		426,010		273,850		305,870
Adverse effects 2/						
Flood prevention structure						
Project installation	2	58,310	5	123,390		
OM&R		3,180		6,160		
Multiple Rec and FP structure						
Project installation	1	156,550			1	156,550
OM&R		59,600				59,600
Project administration		32,440		18,250		23,040
Total adverse effects		310,080		147,800		239,190
Net benefits		115,930		126,050		66,680
Benefit cost ratio		1.37:1		1.85:1		1.28:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

11. Muddy Creek Watershed

Muddy Creek is a tributary of the Lamine River having a 294.85 square mile drainage located in Johnson and Pettis Counties. Both counties have Soil and Water Conservation Districts.

Muddy Creek has severe flooding, sediment, and scour problems. On the 12,710 acres of flood plain having multiple storms each year, 13,050 acres are flooded annually. Floodwater damages are $553,440 annually. Direct crop and pasture damages are $308,980 or 56 percent of the total damages. Scour damages on 3,126 acres amount to $102,230 and sediment damages on 471 acres amount to $26,490. The remaining damages are primarily to fences, roads, bridges and other indirect.

Alternative Plan A proposes two single purpose flood prevention structures and three multiple purpose flood prevention and recreation structures. The five structures control 114.06 square miles or 38.7 percent of the drainage area. Total floodwater prevention benefits are $478,240 (Table 113). Ninety-two percent or $439,980 of the flood prevention benefits occur within the watershed and $38,260 originates downstream on the Lamine River.

The three recreation lakes have 900 acres of water supporting 325,650 visitor days or $488,400 of recreation benefits. Seventy-two percent of the recreation benefits will come from outside the basin. The project is expected to provide $38,170 toward the utilization of unemployed resources. Total beneficial effects amount to $1,004,810 and adverse effects amount to $647,690. Net benefits amount to $357,120.

Alternative Plan B will control 131.10 square miles with 14 single purpose flood prevention structures and two multiple purpose flood prevention and recreation structures. Total flood prevention benefits are $625,070. Benefits within the watershed amount to $583,520 and $41,550 downstream on the Lamine River.

The two recreation structures will have 600 acres of water and with the recreation facilities will accommodate 217,350 recreation visits. Total recreation benefits amount to $325,950. Local employment is expected to benefit by $37,010. Total beneficial effects amount to $988,030 and adverse effects are $643,650. Total net benefits for Plan B are $344,380.

Alternative Plan C proposes two multiple purpose flood prevention and recreation structures controlling 22.49 square miles. The recreation benefits are the same as Plan B. Flood prevention benefits amount to $100,920; within the watershed $92,860 and downstream $8,060. Local employment benefits are $21,940. Total beneficial effects amount to $448,810 and adverse effects amount to $368,470. Total net benefits for Plan C are $80,340.

Table 113.--Muddy Creek Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		281,910		334,450		71,760
More intensive land use		43,280		62,150		4,440
Changed land use		114,790		186,920		16,660
Subtotal		439,980		583,520		92,860
Downstream						
Floodwater damage reduction		35,520		38,360		8,060
More intensive land use		2,740		1,920		
Changed land use				1,270		
Subtotal		38,260		41,550		8,060
Total flood prevention		478,240		625,070		100,920
Recreation		488,400		325,950		325,950
Utilization unemployment		38,170		37,010		21,940
Total beneficial effects		1,004,810		988,030		448,810
Adverse effects 2/						
Flood prevention structure						
Project installation	2	79,210	14	232,630		
OM&R		3,690		10,670		
Multiple Rec and FP structure						
Project installation	3	332,090	2	220,300	2	220,300
OM&R		173,060		115,750		115,750
Project administration		59,640		64,300		32,420
Total adverse effects		647,690		643,650		368,470
Net benefits		357,120		344,380		80,340
Benefit cost ratio		1.55:1		1.54:1		1.21:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

12. Heath Creek Watershed

Heath Creek is a 106.82 square mile tributary entering the Lamine River upstream from its junction with the Blackwater River. This watershed is located in Pettis, Saline, and Cooper Counties all having organized Soil and Water Conservation Districts.

The watershed has 3,110 acres of flood plain which floods an average of 2,620 acres annually. Total floodwater damages are $120,350.

Alternative Plan A has one multiple purpose flood prevention and recreation structure controlling 37.89 square miles. The 350 acre lake is expected to handle 126,250 recreation visits and provide $189,500 of recreation benefits (Table 114). Seventy-two percent of the benefits will come from outside the basin. Total floodwater prevention benefits are $108,450. Ninety-six percent or $103,540 of flood prevention benefits occur within the watershed and $4,910 originates downstream on the Lamine River. The utilization of unemployed labor is $12,420. Total beneficial effects from Plan A amount to $310,370. Total adverse effects are $216,530 leaving $93,840 of net benefits.

Alternative Plan B has five single purpose flood prevention structures and one multiple purpose structure. Total drainage area controlled is 52.71 square miles. The 130 acre lake provides 55,510 recreation visits annually and $83,260 in recreation benefits. Total flood prevention benefits from this control is estimated at $161,680 of which $155,160 comes from within the watershed and $6,520 along the Lamine River. The utilization of unemployed labor is $11,580. Total beneficial effects amount to $256,520. Adverse effects amount to $203,440 leaving $53,080 of net benefits.

Alternative Plan C has the same control as Plan A and same "in watershed" flood prevention benefits, $103,540. Downstream benefits are $5,960 for a total of $109,500. Recreation benefits are the same as Plan A, $189,500. Utilization of unemployed labor is $12,420.

Alternative Plan C proposes a 10.7 mile reach of the lower part of Heath Creek to be developed as an environmental corridor. There are 6,370 acres in the corridor with a high environmental rating. Recreation visits are estimated at 63,700 resulting in a benefit of $47,800. Total annual beneficial effects are $359,220 and adverse effects are $274,100 leaving a net benefit of $85,120.

Table 114.--Heath Creek Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction		67,530		95,340		67,530
More intensive land use		17,480		26,950		17,480
Changed land use		18,530		32,870		18,530
Subtotal		103,540		155,160		103,540
Downstream						
Floodwater damage reduction		4,610		6,020		5,960
More intensive land use		300		300		
Changed land use				200		
Subtotal		4,910		6,520		5,960
Total flood prevention		108,450		161,680		109,500
Recreation		189,500		83,260		189,500
Environmental corridors						47,800
Utilization unemployment		12,420		11,580		12,420
Total beneficial effects		310,370		256,520		359,220
Adverse effects 2/						
Flood prevention structure						
Project installation			5	79,670		
OM&R				3,850		
Multiple Rec and FP structures						
Project installation	1	131,490	1	69,660	1	131,490
OM&R		66,690		29,330		66,690
Environmental corridors						57,570
Project administration		18,350		20,930		18,350
Total adverse effects		216,530		203,440		274,100
Net benefits		93,840		53,080		85,120
Benefit cost ratio		1.43:1		1.26:1		1.31:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

13. Lamine River Watershed

The Lamine River Watershed begins with a drainage area of 537.83 square miles at the junction of Flat Creek and Richland Creek. The drainage area of the Lamine River at the confluence of Blackwater River is 1079.66 square miles. There is an additional 30.85 square miles of drainage in the Lamine River Watershed below the junction of Blackwater River for a total of 1110.51 square miles in the Lamine Subbasin.

The Lamine River Watershed as designated on the map contains 171.01 square miles. The bulk of the watershed is located in Cooper County, however, a small portion of the drainage area is in Morgan and Pettis Counties. Pettis and Cooper Counties have organized Soil and Water Conservation Districts.

The flood plain in the Lamine River Watershed contains 11,740 acres with 8,500 flooded annually. Flooding is severe, particularly on the first bottoms, with total damages estimated at $591,930. Sixty percent of this damage or $352,740 is from crops and pastures. Scour damages on 3,130 acres amounts to $122,310. Remaining damages are to other agricultural properties, roads, bridges, and indirect.

Alternative Plan A has no structural measures in the watershed. There are 445.43 square miles controlled in upstream watersheds which results in $374,240 of floodwater prevention benefits. These benefits have been allocated to upstream watersheds based on drainage area controlled by watersheds.

Alternative Plan B proposes two multiple purpose floodwater prevention and recreation structures controlling 29.51 square miles of drainage. The lakes plus recreational facilities will provide 147,200 recreation visits and $220,800 recreation benefits per year (Table 115). The flood prevention benefits from these two structures amount to $32,730. Benefits resulting from local labor amount to $21,480. Total beneficial effects within the watershed amount to $275,010. With 503.57 square miles controlled in the Lamine Subbasin, $374,240 of floodwater prevention benefits have been allocated to upstream watersheds. Total adverse effects amount to $348,450. Net benefits amount to a negative $73,440.

Alternative Plan C proposes two multiple purpose floodwater prevention and recreation structures which are the same as those in Plan B. The floodwater reduction benefits are slightly higher, $33,950, because of the project formulation in upstream watersheds. Recreation benefits, $220,800, are the same as Plan B. Benefits from utilizing the local labor amounts to $21,480.

Alternative Plan C also proposes a 12.3 mile long environmental corridor of 9,530 acres at the lower end of the watershed. Annual benefits from this area are $71,500. Total beneficial effects amount to $347,730 and adverse effects $434,810, resulting in a negative net benefit of $87,080.

In upstream watersheds 214.74 square miles of the Lamine Subbasin is controlled, resulting in an additional $172,250 of floodwater prevention benefits being allocated to upstream watersheds.

It is recommended that structures on the tributaries be deferred to long range (15 to 25-year period) because of the lack of justification. However, other components of the plan may be considered in an early action plan. Since the Lamine River flood plain will benefit from any early action watershed development upstream, the land treatment program should be accelerated. Also, the environmental corridor proposal in Plan C has one of the highest ratings and should be considered in formulating a project.

Table 115.--Lamine River Watershed, Average Annual Beneficial and Adverse Effects of National Economic Development Account, Blackwater-Lamine River Basin, Missouri

Component	Alternative Plans					
	A		B		C	
	no.	dollars	no.	dollars	no.	dollars
Beneficial Effects 1/						
Flood prevention						
In watershed						
Floodwater damage reduction				30,220		33,950
More intensive land use				1,510		
Changed land use				1,000		
Total flood prevention				32,730		33,950
Recreation				220,800		220,800
Environmental corridors						71,500
Utilization unemployment				21,480		21,480
Total beneficial effects				275,010		347,730
Adverse effects 2/						
Multiple Rec and FP structure						
Project installation			2	228,800	2	228,800
OM&R				84,620		84,620
Environmental corridors						86,360
Project administration				35,030		35,030
Total adverse effects				348,450		434,810
Net benefits				(73,440)		(87,080)
Benefit cost ratio				0.79:1		0.80:1

1/ Projections for year 2000. Current normalized prices, WRC, February 1974
2/ Amortized for 100 years @ 5 5/8 percent interest

ALTERNATIVE PLANS IN BRIEF

The Alternative Plans were discussed in detail in Chapter VI. A brief discussion and probable environmental impacts are discussed here.

1. Alternative Plan A

This alternative proposes adequate land treatment for 190,200 acres of basin lands and construction of 35 single and multiple purpose reservoirs. Land treatment is proposed for 125,300 acres of cropland, 35,900 acres of pastureland, 30,000 acres of forest land and includes 2,091 gully stabilization structures. Structural measures include 14 single purpose flood prevention, 18 multiple purpose flood prevention and recreation and 3 multiple purpose flood prevention and municipal and industrial water storage.

Installation of the accelerated land treatment will reduce sheet and gully erosion from 12.9 to 8.7 million tons per year. The reservoirs will reduce flooding on 113,370 acres and reduce annual flood damages from $4,488,060 to $2,583,680. Recreation pools will provide 6,300 acres of recreation water, and 12,000 acres of adjacent recreation area facilities. Municipal and industrial storage will provide a supply of 13.07 mgd., for the cities of Sedalia, Higginsville and Sweet Springs.

Significant environmental effects include creation of reservoirs which have 8,878 acres of permanent water and will temporarily flood an additional 11,624 acres. Sediment at the mouth of the basin will be reduced from 3,000 to 1,600 acre feet per year. Permanent water will inundate 28 miles of perennial streams and 4,518 acres of cropland. The 12,000 acres of recreation land will increase the area of public land. Reservoirs will supply 2,305,800 visitor days of water based recreation. As a result of flood reduction, 5,682 acres of pastureland and 5,640 acres of forest land could change to cropland.

Cost of installing the land treatment is $16,415,000. The cost of installing the structural measures is $50,014,760.

2. Alternative Plan B

This alternative proposes adequate land treatment for 190,200 acres of basin lands and construction of 102 single and multiple purpose reservoirs. Land treatment is proposed for 125,300 acres of cropland, 35,900 acres of pastureland, 30,000 acres of forest land and 2,019 gully stabilization structures are the same as Plan A. Structural measures include 90 single purpose flood prevention, 10 multiple purpose flood prevention and recreation, and 3 multiple purpose flood prevention, municipal and industrial water storage.

Installation of the accelerated land treatment will reduce sheet and gully erosion from 12.9 to 8.7 million tons per year. The reservoirs will result in a reduction of flooding on 113,370 acres and a reduction of annual flood damages from $4,488,060 to $2,246,040. The 10 multiple purpose reservoirs will supply 892,910 visitor days of recreation. Recreation pools will provide 2,430 acres of recreation water and have 4,860 acres of adjacent land converted to public lands for recreation facilities. Municipal and industrial water storage will provide a supply of 13.07 mgd., for the cities of

Sedalia, Higginsville and Sweet Springs. Thirteen miles of levees and a pumping plant would benefit 3,243 acres.

Significant environmental effects include creation of reservoirs which will have permanent water on 8,474 acres and temporarily flood an additional 21,913 acres. Sediment at the mouth of the basin would be reduced from 3,000 to 1,500 acre feet per year. Permanent water will cover 5.1 miles of perennial streams and 7,290 acres of cropland. The 4,860 acres of recreation land will increase the public land. Reservoirs will supply 892,910 visitor days of water based recreation. As a result of flood protection, 6,655 acres of pastureland, and 8,123 acres of forest land could change to cropland.

Cost of installing the land treatment is $16,415,000. The cost of installing the structural measures is $47,744,970.

3. Alternative Plan C

This alternative proposes adequate land treatment for 443,000 acres of basin lands and construction of 22 multiple purpose reservoirs. Crop and pasturelands now in Class IV, VI and VII would be converted to 41,800 acres of warm season grasses and 100,800 acres of afforestation. Land treatment is proposed for 248,400 acres of cropland, 134,600 acres of pastureland, 60,000 acres of forest land and 2,385 gully stabilization structures. Also, 2,712 miles of roadside erosion control measures are included. Structural measures include 63 single purpose grade stabilization, 9 streambank erosion control, 19 multiple purpose flood prevention and recreation, and 3 multiple purpose flood prevention and municipal and industrial water stroage structures.

Installation of the accelerated land treatment will reduce sheet and gully erosion from 12.9 to 1.8 million tons per year. The reservoirs will result in a reduction of flooding on 113,370 acres and a reduction of annual flood damages from $4,488,060 to $3,335,030. Recreation pools would provide 6,500 acres of recreation water, and 13,000 acres of adjacent recreation facilities. Municipal and industrial storage will provide a supply of 13.07 mgd., for the cities of Sedalia, Higginsville and Sweet Springs.

Significant environmental effects include creation of reservoirs which will have permanent water on 7,710 acres and temporarily flood an additional 3,949 acres. Sediment at the mouth of the basin would be reduced from 3,000 to 700 acre feet per year. Permanent water will inundate 22.4 miles of perennial streams and 4,042 acres of cropland. Reservoirs would supply 2,410,400 visitor days of water based recreation. As a result of flood reduction, 1,803 acres of pastureland and 2,494 acres of forest land could change to cropland.

Cost of installing the land treatment is $49,436,000. The cost of installing the structural measures is $56,835,410.

SHORT-TERM VERSUS LONG-TERM USE OF RESOURCES

By year 2000, land required for urban areas, building sites, roads and service facilities is expected to increase by 85,400 acres or 95 percent.

The four-lane Highways, I-70 and U.S. 50, provide easy access from Kansas City to Johnson and Lafayette Counties and to a lesser extent the remainder of the basin. The increased population from out migration of the Kansas City Metropolitan Area will continue to put pressure on schools, utilities, domestic water supplies, roads and recreation facilities of the basin. Forest land is projected to decrease by 77,700 acres or 26 percent; pasture by 14,300 acres or 3.4 percent; and cropland by 7,200 acres or one percent. By year 2020, land use for food and fiber production is expected to decrease 148,300 acres primarily because of the urban influence and increase in rural population.

Total floodwater damages for year 2000 were determined to be 4.49 million dollars annually on 113,370 acres of flood plain lands. Alternative Plan A proposes to reduce these damages 45 percent; Alternative Plan B by 50 percent; and Alternative Plan C by 26 percent. Alternative Plan A, having 34 percent of the drainage area behind flood control structures, provides flood reduction on 113,370 acres, including 5,682 acres of pasture and 4,640 acres of forest land having a potential for cropland. Alternative Plan B, having 39 percent of the drainage area behind flood control structures, includes flood reduction for 6,655 acres of pasture and 8,123 acres of forest land with a potential for cropland. Alternative Plan C, having 24 percent of the drainage area behind flood control structures, includes flood protection for 1,803 acres of pasture and 2,494 acres of forest land with a potential for cropland.

During project construction, these plans will provide semi-skilled jobs. Plan A will provide 143 jobs, Plan B 153 jobs and Plan C 155 jobs.

Gross erosion was determined to be 15.9 million tons per year. Full implementation of Plans A and B will reduce erosion to 10.9 million tons while Plan C will reduce erosion to 2.9 million tons per year. The proposed land treatment for the year 2000 is expected to treat 125,300 acres of forest land in Alternative Plans A and B. The conservation treatment measures planned would enhance and maintain long-term productivity and would be compatible with short-term uses of the land. The proposed conversion of 100,800 acres of Class IV, VI and VII land in crops and pasture to warm season grasses and afforestation will conserve the productive potential of these lands.

The planned projects are compatible with long-term productivity and human needs. The flood prevention will increase future agricultural production from flood plains. Water demand from developing urban and rural developing population growth will be provided by the proposed water supply reservoirs. Keeping the topsoil on the land through land treatment will reduce sediment pollution of water and land. Constructed reservoirs for flood prevention, water supply and/or recreation will reduce long-term options for those sites used.

Existing water supply reservoirs built by cities and towns will be complemented by the land treatment to be installed. Erosion control of watershed uplands will reduce volume losses caused by sediment deposition. Adequately maintianed reservoirs with land treatment to control sediment will provide water supply beyond their 100-year design life. Land treatment when properly maintained responds to an infinite life span.

In the Blackwater Subbasin, five watersheds have potential for PL-566 projects. The Lamine Subbasin also has five watersheds with potential for PL-566 projects. The watershed projects in the basin will be cumulative and provide a significant reduction of flood damages along the Blackwater and Lamine River. The water-based recreation will supplement the land-based Knob Noster State Park. It will satisfy a portion of the demand in the 30 minute, one-hour and two-hour time zones from population centers. The proposed water supply will supplement or replace existing systems that are inadequate or expected to be inadequate by year 2000.

The basin is within four Regional Planning Commission Areas. They are Lake of the Ozarks, Mid-Missouri, Missouri Valley and Show-Me Regional Planning Commission. Each has prepared plans for their regions. These plans cover the following subjects related to water resource development--Water and Sewer, Open Space and Recreation, and Natural Resources. These River Basin studies provide supplemental information and potential solutions to their water resource and storage needs.

A Pilot Watershed, East Branch of South Fork of Blackwater River, was completed in 1958. Twenty-one gully control structures were built. The Plan for the South Fork of Blackwater River Watershed was completed in 1962. Four floodwater and 9 grade stabilization structures were built. A revised plan complete in 1972 added 5 floodwater retarding structures.

Under two Congressional resolutions, the Corps of Engineers have made studies on the Blackwater-Lamine Basin and on Flat Creek, a tributary of the Lamine River. No works of improvement were proposed.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

As a result of reservoir construction proposed in each plan, permanent water, spillways, dams and recreational areas will commit resources to other uses (Table 116).

Table 116.--Land Use Changes Resulting From Reservoir Construction, Blackwater-Lamine River Basin, Missouri

	Alternative Plans		
	A	B	C
	- - - - - - - acres - - - - - - - - - -		
Cropland to permanent water	4,518	4,099	4,042
Pastureland to permanent water	1,437	1,470	1,251
Forest land to permanent water	2,923	2,905	2,417

The value of agricultural and forestry production will be forgone because of this proposed construction in the permanent pool, the flood pools and the recreational facility areas (Table 117). The irretrievable value of fossil fuel used in construction is over $3,000,000 for each plan.

Table 117.--Value of Production Forgone in Reservoir Areas, Blackwater-Lamine River Basin, Missouri

	Alternative Plans		
	A	B	C
	dollars		
Permanent pool	201,000	342,000	329,000
Flood pool	190,000	498,000	301,000
Recreation facility area	204,000	167,000	495,000
Total	595,000	1,007,000	1,125,000
Value loss of fossil fuel during construction	3,106,880	3,101,170	3,360,340

CHAPTER VIII

Coordination and Programs for Further Development

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

This report presents three alternative plans for consideration. Primarily these alternatives are tools for use in selecting a comprehensive plan that meets state and local needs. Each presents different levels of meeting basin needs for most study items. Local groups and state agencies should develop final objectives and decide upon a comprehensive plan for development. Coordination is needed on all levels to orderly implement comprehensive programs for developing the water and related land resources.

The coordination vehicle used for bringing a plan to completion is usually through local groups organized under state enabling acts. The potential for development under USDA Programs are discussed in Chapter VII. Other existing federal, state, county and city programs that may be needed to implement a comprehensive plan are discussed in this section.

FEDERAL PROGRAMS

1. U.S. Department of Interior, Bureau of Outdoor Recreation

The Land Water Conservation Fund Act of 1965 (PL 88-578) established a fund to increase outdoor recreation opportunities. The program provides for: (1) acquisition of lands for federally administered recreation areas; (2) matching grants for state recreation planning, and state or local land acquisition and development. The fund is administered by the Bureau of Outdoor Recreation. Land and water funds are distributed through the Missouri Council of Outdoor Recreation, Department of Natural Resources. These funds are available to states, counties and cities for the acquisition of recreational lands.

2. U.S. Department of Interior, Bureau of Sport Fisheries and Wildlife has several programs with local governments, states, federal and interstate agencies, non-profit organizations, private enterprises, and individuals. Their primary purposes are to preserve and maintain wildlife habitats, establish systems of public use and promote recreational pursuits directly associated with wildlife and its natural habitat. This program for improved habitat meets some of the needs for land treatment and changed land use.

3. Department of Housing and Urban Development, Community Development Act of 1974 (PL 93-383), Sec. 105 assists community development program activities in acquisition of real property (including air rights, water rights and other interests therein). This real property is either appropriate for: (1) rehabilitation or conservation activities; (2) the preservation or restoration of historic sites, the beautification of urban land, the conservation of open spaces, natural resources, and scenic areas, the provision of recreational opportunities or the guidance or urban development, or (3) to be used for other public purposes. Assistance from this act would be applicable to acquiring historic sites or community land for recreational uses.

4. Department of Housing and Urban Development, Flood Insurance Program provides information concerning the 100 and 500-year frequency floods. Flood insurance is available to those in the 100-year flood plain.

Future floodwater losses can be reduced or averted in the communities of Blackwater, Sweet Springs, Warrensburg and Sedalia because of building restrictions of the flood plain.

STATE PROGRAMS

1. The Missouri State Park Board acquires and manages land for recreational purposes. Their cooperation and participation by cost sharing on recreational development will be required to implement major recreational development. Financial assistance from the Land and Water Fund, BOR is available for certain recreational developments.

2. The Missouri Department of Conservation has land and water acquisition programs for purposes of conservation, recreation, preservation and public service. At present, the Department of Conservation plans to expand its land acquisition program along the Blackwater River in Saline, Pettis and Cooper Counties. These lands are highly desirable for stream access, wildlife and natural areas. The programs will primarily improve wildlife habitat through acquisition and management of land. Small reservoirs are built that will meet some of the demand for fishing with assistance from the Land and Water Fund, BOR.

REGIONAL, CITIES AND OTHER PROGRAMS

1. Enabling legislation in Missouri has provided a means for groups to organize a drainage district. They have broad powers to levee taxes on benefitted areas and construct works of improvement. Primary purpose would be to reduce flood damages and provide drainage outlets.

2. Soil and Water Conservation Districts are organized to develop individual resource conservation plans and establish soil conservation practices. All counties in the basin except Morgan County have established Soil and Water Conservation Districts. These districts have programs for attacking the erosion and other land treatment needs.

3. A watershed sub-district is organized for special benefits. It provides the organization to develop plans, raise local cost shares, let contracts and complete construction on watershed projects. This sub-district provides local leadership for accomplishing the land treatment as well as structural measures such as: flood retarding structures; gully control structures; multiple-purpose structures with recreation water supply and recreation facilities. Watershed sub-districts can stimulate individual and group action, to develop the early action watershed projects in this report.

4. Multi-county areas along Regional Planning boundaries can be organized into a Resource Conservation and Development Project. Under this authority individual project measures are planned and constructed. A wide variety of potential project measures can be developed ranging from controlling roadside erosion, establishing environmental corridors to a multiple purpose flood prevention and water supply reservoir. Many land treatment and structural measures not applicable to other programs can be built as separate individual project measures. The Blackwater-Lamine River Basin has a potential to develop multiple county RC&D projects to assist in improving the overall economic and social conditions.

PROJECTS FOR JOINT PLANNING

The U.S. Corps of Engineers have authority for the planning and construction of large reservoirs for flood prevention, recreation, water supply and other purposes. This authority would be applicable for developing the multi-purpose structure site on Clear Creek displayed in Alternative Plans A and C, which is beyond the authority of PL-566. The Missouri State Park Board should consider the expansion of Knob Noster State Park to include the proposed lake and the additional segments of the environmental corridors along Clear Creek. Financial assistance from the Land and Water Fund, BOR is available for certain recreational developments through the Missouri Council of Outdoor Recreation.

GLOSSARY

Accelerated forestry program - An increased effort to accomplish forest land treatment measures, usually through PL-566 or RC&D Programs.

Accretion - The gradual addition of new land to old by the deposition of sediment carried by the water of a stream.

Acre-foot - The volume of water that will cover 1 acre to a depth of 1 foot.

Activity-day - Participation by an individual in a specific outdoor recreation activity during any part of a day. "Activity-occasion" is an interchangeable term with the same meaning.

Aesthetic appeal - The beauty or pleasure response from viewing desirable landscapes.

Afforestation - The artificial establishment of forest vegetation by planting or sowing on land that has not previously, or not recently, grown trees or shrubs.

Aggradation - The process of building up a surface by deposition. This is a long-term or geologic trend in sedimentation.

Agricultural land - Land in farms regularly used for agricultural production. The term includes all land devoted to crop or livestock enterprises, for example, the farmstead lands, drainage and irrigation ditches, water supply, cropland, and grazing land of every kind in farms.

Alkali - In chemistry, any substance having marked basic properties in contradistinction with acid, that is being capable of furnishing to its solution or other substances the hydroxyl ion (OH negative). The important alkali metals are sodium and potassium. In a less scientific sense the term is applied to the soluble salts, especially the sulfates and chlorides of sodium, potassium, and magnesium and the carbonates of sodium, which are present in some soils of arid and semiarid regions in sufficient quantities to be detrimental to ordinary agriculture.

Alluvial - Pertaining to material that is transported and deposited by running water.

Alluvial soils - An azonal great soil group of soils, developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the original material by soil-forming processes.

Alluvium - A general term for all detrital material deposited or in transit by streams, including gravel, sand, silt, clay, and all variations and mixtures of these. Unless otherwise noted, alluvium is unconsolidated.

Aquifer - A geologic formation or structure that transmits water in sufficient quantity to supply the needs for a water development. The term waterbearing is sometimes used synonymously with aquifer when a stratum furnishes water for a specific use. Aquifers are usually saturated sands, gravel,

fractures, cavernous and vesicular rock.

Average annual flood damages - Expression of damage values as a uniform annual series that considers the nonuniform rate of damage accrual. Each yearly damage is reduced to its present worth, and the sum of these present worths is spread uniformly over the period of analysis.

Basal area (forestry) - The area of the cross section at breast height of a single tree or of all the trees in a stand, usually expressed by square feet. This may be measured inside or outside the bark, usually the latter, (range) - The area of ground surface covered by the stem or stems of a range plant, usually measured 1 inch above the soil in contrast to the full spread of the foliage.

Base flow - The stream discharge from ground water.

Basic employment - Employment in industries within a specified area which produces a volume that is transported and sold in other areas.

Basin (hydrology) - The area drained by a river. (irrigation) - A level plot or field, surrounded by dikes, which may be flood irrigated.

Bedload - The sediment that moves by sliding, rolling, or bounding on or very near the streambed.

Bedrock - The solid rock in place either on or beneath the surface of the earth.

Biota - The flora and fauna of a region.

Board foot - A unit of measure of the wood in lumber, logs, bolts, or trees; it is the amount of wood in a board 1 foot wide, 1 foot long, and 1 inch thick before surfacing or other finishing. Abbr. bd. ft.

Browse - Twigs or shoots, with or without attached leaves, of shrubs, trees, or woody vines available as forage for domestic and wild browsing animals.

Buffer strips - Strips of grass or other erosion-resisting vegetation between or below cultivated strips or fields.

Canopy - The cover of leaves and branches formed by the tops or crowns of plants.

Carbonaceous - Pertaining to or containing carbon derived from plant and animal residues.

Census of Agriculture - A census taken by the Bureau of Census every 5 years. It includes number of farms, land in farms, crop acreage and production, livestock numbers and production, farm spending, farm facilities and equipment, farm tenure, value of farm products sold, farm size, etc. Data are given for states and counties.

Channel - A natural stream that conveys water; a ditch or channel excavated for the flow of water.

Channel improvement - The improvement of the flow characteristics of a channel by clearing, excavation, realignment, lining, or other means in order to increase its capacity. Sometimes used to connote channel stabilization.

Channel stabilization - Erosion prevention and stabilization of velocity distribution in a channel using jetties, drops, revetments, vegetation, and other measures.

Cherty - An adjective incorporated into the soil textural class designations of horizons when the soil mass contains between 15 and 90 percent by volume of chert fragments. See chert fragments and coarse chert fragments as defined under coarse fragments.

Claypan - A dense, compact layer in the subsoil having a much higher clay content than the overlying material from which it is separated by a sharply defined boundary; formed by downward movement of clay or by synthesis of clay in place during soil formation. Claypans are usually hard when dry and plastic and sticky when wet. They usually impede the movement of water and air. With adequate fertility they often do not impede plant roots. See hardpan.

Clearcutting (forestry) - A method of cutting that removes the entire timber stand on the area cut. Contrast with selective cutting.

Climate, continental - The type of climate characteristic of land areas separated from the moderating influence of oceans by distance, direction, or mountain barriers, marked by relatively large daily and seasonal change in temperature.

Climax vegetation - Relatively stable vegetation in equilibrium with its environment and with good reproduction of the dominant plants.

Commercial forest land - Forest land that is producing or is capable of producing crops of industrial wood and is not withdrawn from timber utilization by statute or administrative regulation.

Cool-season plant - A plant that makes its major growth during the cool portion of the year, primarily in the spring but in some localities in the winter.

Cord - A unit of measurement of stacked wood containing 128 cubic feet within its outside surfaces. The standard cord is a pile of wood 4 feet by 8 feet, made up of sticks 4 feet long.

Cost allocation - The process of apportioning cost among the various purposes served by a measure or work of improvement.

Cover (wildlife) - Plants or objects used by wild animals for nesting, rearing of young, resting, escape from predators, or protection from adverse environmental conditions.

Cropland - Land used primarily for the production of adapted cultivated, closegrowing, fruit, or nut crops for harvest, alone or in association with sod crops.

Cubic foot per second - Rate of fluid flow at which 1 cubic foot of fluid passes a measuring point in 1 second. Abbr. cfs. Syn. Second-foot; CUSEC.

D.B.H. - Diameter breast high; the diameter of the bole of a tree at 4 1/2 feet above the average ground level.

Deciduous plant - A plant that sheds all its leaves every year at a certain season.

Decreaser plant species - Plant species in the original vegetation that will decrease in relative amount with continued overuse, often termed decreasers.

Degradation - To wear down by erosion, especially through stream action.

Deposit - Material left in a new position by a natural transporting agent, such as water, wind, ice, or gravity, or by the activity of man.

Deposition - The accumulation of material dropped because of a slackening movement of the transporting agent - water or wind.

Desirable trees - Growing-stock trees having no serious defects in quality that limits present or prospective use. These are trees that would be favored by forest managers in silvicultural operations because of greater commercial value.

Discharge (hydraulics) - Rate of flow, specifically fluid flow; a volume of fluid passing a point per unit time, commonly expressed as cubic feet per second, million gallons per day, gallons per minute, or cubic meters per second.

Dissolved oxygen - The amount of oxygen gas dissolved in water. It is commonly expressed in mg/1. The solubility of oxygen varies inversely with temperature - the higher the temperature the less oxygen can be dissolved in the water.

Diversion - Channel constructed across the slope for the purpose of intercepting surface runoff; changing the accustomed course of all or part of a stream. See terrace.

Diversion terrace - Diversions, which differ from terraces in that they consist of individually designed channels across a hillside, may be used to protect bottom land from hillside runoff or may be needed above a terrace system for protection against runoff from an unterraced area. They may also divert water out of active gullies, protect farm building from runoff, reduce the number of waterways, and are sometimes used in connection with stripcropping to shorten the length of slope so that the strips can effectively control erosion. See terrace.

Dominant species - Species of a community which are controlling and often the most abundant.

Drainage - 1: The removal of excess surface water or ground water from land by means of surface or subsurface drains. 2: Soil characteristics that affect natural drainage.

Drainage district - A cooperative, self-governing public corporation created under state law to finance, construct, operate, and maintain a drainage system involving a group of land holdings.

Drift, glacial - Rock debris transported by glaciers and deposited either directly from the ice or from the meltwater. The debris may or may not be heterogenous.

Ecological quality - A diversity of plant and animal species that provide an energy balanced ecosystem.

Ecosystem - Energy-driven complex of a community of organisms and its controlling environment.

Edge (wildlife) - The transitional zone where one cover type ends and another begins.

Effluent - 1: The discharge or outflow of water from ground or sub-surface storage. 2: The fluids discharged from domestic, industrial, and municipal waste collection systems or treatment facilities.

Environment - The sum total of all the external conditions that may act upon an organism or community to influence its development or existence.

Environmental corridors - Linear water-oriented areas reserved for managed use and maintained or left in or developed to a condition that can enhance man's environment.

Ephemeral stream - A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from snow or other sources. Its channel is at all times above the water table.

EROSION--
Accelerated erosion - Erosion much more rapid than normal, natural, or geologic erosion, primarily as a result of the influence of the activities of man or, in some cases, of other animals or natural catastrophies that expose base surfaces, for example, fires.
Geological erosion - The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of flood plains, coastal plains, etc. Syn. natural erosion.
Gully erosion - The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, ranging from 1 to 2 feet to as much as 75 to 100 feet.

Natural erosion - Wearing away of the earth's surface by water, ice, or other natural agents under natural environmental conditions of climate, vegetation, etc., undisturbed by man. Syn. geological erosion.
Normal erosion - The gradual erosion of land used by man which does not greatly exceed natural erosion. See natural erosion.
Rill erosion - An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently cultivated soils. See rill.
Sheet erosion - The removal of a fairly uniform layer of soil from the land surface by runoff water.

Evapotranspiration - Water transpired by vegetation plus that evaporated from the soil. Syn. consumptive use.

Externalities (pecuniary) - Relates to changes in income of firms economically related to direct and indirect users of project output.

Fauna - The animal life of a region.

Fiberboard - Reconstituted wood that was first reduced to small fractions and then put back together by special forms of manufacture into panels of relatively large size and moderate thickness.

Flood - An overflow or inundation that comes from a river or other body of water and causes or threatens damage.

Flood control - Methods or facilities for reducing flood flows.

Flood control project - A structural system installed for protection of land and improvements from floods by the construction of dikes, river embankments, channels or dams.

Flood peak - The highest value of the stage or discharge attained by a flood, thus, peak stage or peak discharge.

Flood plain - Nearly level land situated on either side of a channel which is subject to overflow flooding.

Flood stage - The stage at which overflow of the natural banks of a stream begins to cause damage in the reach in which the elevation is measured.

Floodwater or flood damage - The economic loss caused by floods, including damage by inundation, erosion, scour, or sediment deposition on flood plain areas. Floodwater damages result from physical damages or losses, emergency, costs, and business or financial losses. Evaluation may be based on the cost of replacing, repairing, or rehabilitating; the comparative change in market or sales value; or the change in income or production caused by flood experience.

Flora - The sum total of the kinds of plants in an area at one time.

Forage - All browse and herbaceous food that is available to livestock or game animals, used for grazing or harvested for feeding.

Forb - A herbaceous plant which is not a grass, sedge, or rush.

Forest land - Areas at least 10 percent stocked with species of forest trees as well as land from which the trees have been removed to less than 10 percent stocking. The minimum size of tract recognized as forest is 1 acre; the minimum width for a wooded strip is 120 feet.

Forest management - The application of business methods and technical forestry principles to the operation of a forest property.

Forest type - A tract of forest land in which one or more predominate species make up a specified proportion of the stand.

Fragipan - A natural subsurface horizon with high bulk density relative to the solum above, seemingly cemented when dry but showing a moderate to weak brittleness when moist. The layer is low in organic matter, mottled, slowly or very slowly permeable to water, and usually shows occasional or frequent bleached cracks forming polygons. It may be found in profiles of either cultivated or virgin soils but not in calcareous material.

Frequency - A statistical expression of the presence or absence of individuals of a species in a series of subsamples, that is, the ratio between the number of sample areas that contains a species and the total number of sample areas.

Fuelwood - Fireplace wood, An average family uses 1 to 1 1/2 cords per year.

Furbearer - A mammal sought for its fur.

Gage or gauge - Device for registering precipitation, water level, discharge, velocity, pressure, temperature, etc.

Gaging station - A selected section of a stream channel equipped with a gage, recorder, or other facilities for determining stream discharge.

Game animal - An animal sought for its fur, flesh, or trophy value, or one so defined by law.

Glaciofluvial deposits - Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and may occur in the form of outwash plains, deltas, kames, eskers, and kame terraces. See glacial drift; till.

Going programs - The non-accelerated cooperative programs with federal, state and local governments, forest industries, and private landowners for purposes of protection, management, and use of forest and their products.

Grade stabilization structure - A structure for the purpose of stabilizing the grade of a gully or other watercourse, thereby preventing further head-cutting or lowering of the channel grade.

Grassland - Land on which the existing plant cover is dominated by grasses. See natural grassland.

Grazing control - The managed regulation of the eating of any kind of standing vegetation by domestic livestock or wild animals by fencing.

Ground water - Phreatic water or subsurface water in the zone of saturation.

Growing stock - The sum, by number or volume, of all the live trees in a forest or a specified part of it.

Gully - A channel or miniature valley cut by concentrated runoff but through which water commonly flows only during and immediately after heavy rains or during the melting of snow. A gully may be dendritic or branching or it may be linear, rather long, narrow, and of uniform width. The distinction between gully and rill is one of depth. A gully is sufficiently deep that it would not be obliterated by normal tillage operations, whereas a rill is of lesser depth and would be smoothed by ordinary farm tillage. Syn Arroyo. See erosion; rill.

Habitat - The environment in which the life needs of a plant or animal are supplied.

Headwater - 1: The source of a stream. 2: The water upstream from a structure or point on a stream.

Heavy soil - A commonly used term to describe various fine-textured soils.

Humid - A term applied to regions or climates where moisture, when distributed normally throughout the year, should not be a limiting factor in the production of most crops. The lower limit of precipitation under cool climates may be as little as 20 inches annually. In hot climstes it may be as much as 60 inches. Natural vegetation is generally forest. Contrast with sub-humid.

Increaser plant species - Plant species of the original vegetation that increase in relative amount, at least for a time, under overuse. Commonly termed increasers.

Infiltration - The flow of a liquid into a substance through pores or other openings, connoting flow into a soil in contradistinction to the work percolation which connotes flow through a porous substance.

Installation cost - The monetary cost of physically performing project measures, i.e. tree planting labor cost.

Interspersion (wildlife) - The distribution of heterogeneous cover types and plant species in a limited area.

Invader plant species - Plant species that were absent in undisturbed portions of the original vegetation and will invade under disturbance or continued overuse. Commonly termed invaders.

Lagoon, sewage - Ponding effluent for septic action.

Land Capability Class - One of the eight classes of land in the land capability classification of the Soil Conservation Service. These eight land capability classes, distinguished according to the risk of land damage or the difficulty of land use, are:

--Land suitable for cultivation and other uses.

I. Soils in class I have few limitations that restrict their use.

II. Soils in class II have some limitations that reduce the choice of plants or require moderate conservation practices.

III. Soils in class III have severe limitations that reduce the choice of plants or require special conservation practices, or both.

IV. Soilsin class IV have very severe limitations that restrict the choice of plants, require very careful management, or both.

--Land generally not suitable for cultivation (without major treatment).

V. Soils in class V have little or no erosion hazard but have other limitations, impractical to remove, that limit their use largely pasture, range, woodland, or wildlife food and cover.

VI. Soils in class VI have severe limitations that make them generally unsuited for cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

VII. Soils in class VII have very severe limitations that make them unsuited to cultivation and that restricts their use largely to grazing, woodland, or wildlife.

VIII. Soils and landforms in class VIII have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Land adequately managed or treated - This group includes all land on which the use, management, and treatment meets the minimum standards of the conservation programs of the SCS, the Soil Conservation Districts, the Indian Service, or of the Federal Land Management Agency concerned. It includes all types of management, vegetation, and mechanical practices.

Land easement - The payment to the landowner for the right or privilege in respect to a specific use or enjoyment by another person or for the benefit of another thing.

Land resource area - An area of land reasonably alike in its relationship to agriculture with emphasis on combinations and/or intensities of problems in soil and water conservation, ordinarily larger than a land resource unit and smaller than a land resource region.

Land resource areas - Broad, geographic areas having similar soil, climatic, geologic, vegetative, and topographic features.

Land resource region - A generalized grouping of land resource areas reflecting regional relationships to agriculture with emphasis on soil and water conservation.

Land resource unit - A subdivision of a land resource area with emphasis on a specialized type of agriculture, intensities, or problems in soil and water conservation. It has a narrower range in relationship to agriculture with emphasis on soil and water conservation.

Land treatment measure - In forestry, reference to the practice necessary to improve watershed protection or increase forest resources.

Legume - A member of the legume or pulse family, LEGUMINOSAE. One of the most important and widely distributed plant families. The fruit is a "legume" or pod that opens along two sutures when ripe. Flowers are usually papilionaceous (butterflylike). Leaves are alternate, have stipules, and are usually compound. Includes many valuable food and forage species, such as the peas, beans, peanuts, clovers, alfalfas, sweet clovers, lespedezas, vetches, and kudzu. Practically all legumes are nitrogen-fixing plants.

Light soil - A coarse-textured soil with a low drawbar pull and, hence, easy to cultivate. See coarse texture; soil texture.

Linear water - Oriented areas with a combination of resources such as forest, wildlife, and recreation that has the potential to enhance man's environment.

Loamy - Intermediate in texture and properties between fine-textured and coarse-textured soils. Includes all textural classes with the word "loam" as a part of the class name, such as clay loam. See loam; soil texture. See particle size classes for family groupings for its use in the Soil Classification System of the National Cooperative Soil Survey in the United States.

Loess - Material transported and deposited by wind and consisting of predominantly silt-sized particles.

Marketable forest products - The products or outputs of forest land that can be sold or used on farm, i.e. fence posts or sawlogs.

Marsh - Periodically wet or continually flooded area with the surface not deeply submerged. Covered dominantly with sedges, cattails, rushes, or other hydrophytic plants. Sub-classes include freshwater and saltwater marshes. See swamp; miscellaneous land type.

Meadow - An area of natural or planted vegetation dominated by grasses and grasslike plants used primarily for hay production.

Multi-cropping - A management technique in which walnuts, timber, hay and pasture might be produced from a given acre.

Native species - A species that is a part of an area's original fauna or flora.

Natural grassland - An area in which the natural potential plant community is dominated by grasses and grasslike plants. Associated species include forbs and woody plants.

Natural scenic area - Area with exceptional scenery, fauna or flora, and geological or mineral interest, with or without minimum development for access.

Net annual growth of growing stock - The annual change in volume of sound wood in live sawtimber and poletimber trees during a specified period resulting from natural causes.

Niche (wildlife) - The place in the plant or animal community that a species may occupy.

Non-commercial forest land - Forest land, such as state parks, that qualifies as commercial forest, but is withdrawn from timber utilization through statute, ordinance, or administrative order; or forest land that is incapable of yielding a stand averaging at least one 13 foot sawlog per tree.

Nonstocked - Areas of commercial forest land on which stocking of growing stock trees is less than 10 percent.

Nut production - The amount of black walnut nuts grown each year.

Odd area (wildlife) - A small area of land, such as a bare knob, fence corner, sink hole, blow-out, borrow pit, or an irregularly shaped area, that may be best used to produce wildlife habitat.

Operation and maintenance costs - Average annual costs of project operation and normal maintenance.

Outdoor recreation carrying capacity - The number of people an area or facility can handle at a given time without resource damage.

Outdoor recreation demand - A measure of outdoor recreation participation in activity-days or recreation-days, given a certain set of socio-economic and opportunity conditions.

Peak discharge - See flood peak.

Percolation, soil water - The downward movement of water through soil, especially the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.

Permeability - Capacity for transmitting a fluid. It is measured by the rate at which a fluid of standard viscosity can move through material in a given interval of time under a given hydraulic gradient.

Plant succession - The process of vegetation development whereby an area becomes successively occupied by different plant communities of higher ecological order.

PL-46 - The establishing and enabling act of the Soil Conservation Service Public 46 - 74th Congress, 49 Stat. 163, 164 (16 U.S.C. 590a-590f) was approved on April 27, 1935. This act directed the Secretary of Agriculture to establish an agency to be known as the "Soil Conservation Service" to exercise the powers conferred on him by the act.

PL-566 - The Watershed Protection and Flood Prevention Act (Public Law 566 - 83d Congress) was approved. The act authorized a permanent program by which the Department of Agriculture provides technical and financial assistance to local watershed groups willing to assume responsibility for initiating, carrying out, and sharing the costs of upstream watershed conservation and flood control.

Poletimber size class - Live merchantable hardwood trees species between 5.0 inches and 10.9 d.b.h.

Poletimber stands - Stands failing to meet specifications for sawtimber but at least 10 percent stocked with trees 5.0 inches d.b.h. or larger with at least half of the minimum stocking in poletimber-size trees.

Pollution, water - Any change in the character of water adversely affecting its usefulness.

Potential plant community - See climax vegetation.

Pulpwood - Wood products that could be ground up into pulp for the making of paper or chip products.

Recreation-day - A visit by an individual to a recreation area for recreation purposes during a significant portion or all of a 24-hour day.

Recreation demands - The quantity of recreation demanded at existing user prices, some of which are near zero.

Recreation visit - A visit by an individual to a recreation area for recreation purposes during a significant portion or all of a 24-hour day. Syn. recreation day.

Reforestation - Restocking an area with forest trees.

Reservoir - A pond, lake, or basin, either natural or artificial, for the storage, regulation, and control of water.
Multiple-purpose reservoir - A reservoir planned to be used for more than one purpose.
Retarding reservoir - Ungated reservoir for temporary storage of floodwater. Sometimes called a detention reservoir.
Single-purpose reservoir - A reservoir planned to be used for only one purpose.

River basin plan - A plan for development of water and related land resources to make the best use of such resources to meet the basin needs and make the greatest long-term contribution to the economic growth and social well-being of the people of the basin and the nation.

Runoff (hydraulics) - That portion of the precipitation on a drainage area that is discharged from the area in stream channels. Types include surface runoff, ground water runoff, or seepage.

Sawtimber size class trees - Live merchantable trees 11.0 inches diameter, breast height and larger.

Sawtimber stands - Stands having a minimum net volume in live merchantable sawtimber trees of commercial species of 1,500 board feet per acre, International 1/4 inch rule.

Sawtimber volume - Net volume in board feet, International 1/4 inch rule of merchantable sawlogs in live sawtimber trees. Net volume equals gross volume less deductions for rot, sweep, and other defects that affect use for lumber.

Scour - To abrade and wear away. Used to describe the wearing away of terrace or diversion channels or stream beds.

Sediment - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

Sediment discharge - The quantity of sediment, measured in dry weight or by volume, transported through a stream cross section in a given time. Sediment discharge consists of both suspended and load and bedload.

Sedimentary rocks - Formed by lithification of sediments, mechanical, chemical, or organic. Two broad categories are clastic and chemical.

Seedlings and saplings - Trees less than 5.0 inches d.b.h. with no merchantable value.

Site (ecology) - 1: An area considered for its ecological factors with reference to capacity to produce vegetation; the combination of biotic, climatic, and soil conditions of an area. 2: An area sufficiently uniform in soil, climate, and natural biotic conditions to produce a particular climax vegetation.

Site index (forestry) - A numerical expression commonly accepted as an indicator of the quality or timber productivity of a site. It is an expression of the height-age relationship of the tallest trees (dominants and codominants) in normal stands at some designated age, such as 50 years.

Soil - 1: The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. 2: The unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors of parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time and producing a product--soil--that differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics. 3: A kind of soil is the collection of soils that are alike in specified combinations of characteristics. Kinds of soil are given names in the system of soil classification. The terms "the soil" and "soil" are collective terms used for all soils, equivalent to the work "vegetation" for all plants.

Soil survey - A general term for the systematic examination of soils in the field and in laboratories; their description and classification; the mapping of kinds of soil; the interpretation of soils according to their adaptability for various crops, grasses, and trees; their behavior under use or treatment for plant production or for other purposes; and their productivity under different management systems.

Solids, dissolved - Solids that are dissolved in (sewage). None of the dissolved solids are settleable.

Stabilized grade - The slope of a channel at which neither erosion nor deposition occurs.

Stand - An aggregation of trees or woody vegetation occupying an area of 1 acre or more.

State soil conservation committee, commission, or board - The state agency established by state soil conservation district enabling legislation to assist with the administration of the provisions of the state soil conservation districts law. The official title may vary from the above as new or amended state laws are made.

Stocking - The degree to which an area is effectively covered with living trees. Fully stocked stands contain as many trees per acre as can properly use the growing space available.

Stream - A general term for a body of flowing water. In hydrology the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, as in the term stream gaging, it is applied to the water flowing in any channel, natural or artificial.

Streambanks - The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream.

Surface water - The water on the surface of the land, representing the drainage from the land. When we speak of surface water we mean streamflow, regardless of its source. Lakes and reservoirs are viewed as streamflow in storage.

Swamp - An area saturated with water throughout much of the year but with the surface of the soil usually not deeply submerged, usually characterized by tree or shrub vegetation. See marsh; miscellaneous land type.

Technical assistance - Aid available for professional forestry information and advice on the treatment of trees and forest land.

Technical externalities - Changes in income of a person or firm due to efficiency of production functions resulting from improved technology from the action of a different person or firm.

Temporary pasture - A pasture designed to provide grazing for only a short period, usually consisting of annual plants.

Terrace - An embankment or combination of an embankment and channel constructed across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope. Terraces or terrace systems may be classified by their alignment, gradient, outlet, and cross section. Alignment is parallel or non-parallel. Gradient may be level, uniformly graded, or variably graded. Grade is often incorporated to permit paralleling the terraces. Outlets may be soil infiltration only, vegetated waterways, tile outlets, or combinations of these. Cross sections may be narrow base, broad base, bench, steep backslope, flat channel, or channel.

Till - 1: Unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel, and boulders intermingled in any proportion. 2: To plow and prepare for seeding; to seed or cultivate the soil.

Timber stand improvement (TSI) - The cultural operations of cleaning sapling stands, thinning pole and small sawtimber stands and cull tree removal for purposes of improving the existing stand of trees.

Understory - That portion of the trees in a forest below the upper crown cover. Syn. underwood. Contrast with overstory.

Vacation farm - A rural area operated as a working or simulated farm with vacation living accommodations for rent.

Vegetation - Plants in general or the sum total of plant life in an area.

Vegetation type - A plant community with distinguishable characteristics.

Volume of growing stock - The volume in cubic feet of sound wood in the bole of growing-stock trees, from a 1-foot stump to a minimum 4.0-inch top diameter inside bark.

Volume of sawtimber - Net volume of the saw log portion of live sawtimber trees in board feet international 1/4-inch rule measured between the stump and a point in the top of the stem at which utilization is limited by large branches, fork or other defects, or by a diameter inside bark of 8-inches.

Warm-season plant - A plant that completes most of its growth during the warm portion of the year, generally late spring and summer.

Water quality standards - Minimum requirements of purity of water for various uses; for example, water for agricultural use in irrigation systems should not exceed specific levels of sodium bicarbonates, pH, total dissolved salts, etc.

Watershed area - All land and water within the confines of a drainage divide or a water problem area consisting in whole or in part of land needing drainage or irrigation.

Watershed planning - Formulation of a plan to use and treat water and land resources.

Water yield - The runoff from the drainage basin, including ground water outflow that appears in the stream, plus ground water outflow that bypasses the gaging station and leaves the basin underground, and minus ground water inflow that moves into the drainage basin underground from adjacent drainage basins. Water yield is the precipitation minus the evapotranspiration.

Wildfire - Uncontrolled or unsuppressed fire that is highly destructive and difficult to extinguish.

Wood product industry - Establishments primarily engaged in the utilization of various wood raw materials.

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